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ABSTRACT

The purpose of this report is to characterize American graduate education in the 1960s and to identify many of the issues that will determine the character, magnitude, and direction of graduate education, especially in the sciences and engineering, during the next decade. In Chapter 1, Dimensions of Graduate Education, some of the salient features of institutional demography are presented, including: the number of graduate institutions, their types, locations, and transformations; the distribution of graduate enrollment; the number and types of degrees awarded; and representative projections to 1980-81. Chapter 2, Correlates of Quality, reviews a number of factors that appear to be generally associated with quality either of institutions or departments, including: magnitude of graduate program, institutional funding, baccalaureate origins of doctorates, freshman admission selectivity, selection of institution by graduate fellowship recipients, doctoral awards per faculty member and per student, faculty compensation and structure, student-faculty ratio, and minimum size. In Chapter 3, Financial Perspectives, financial patterns and trends in universities are examined. Particular emphasis is placed on the research role in graduate education, essential characteristics of academic accounting practice, and the inherent cost of graduate education in relation to higher education as a whole. The Summary lists some of the principal conclusions. (AF)

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GRADUATE EDUCATION

PARAMETERS FOR PUBLIC POLICY

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REPORT PREPARED FOR
THE NATIONAL SCIENCE BOARD

NATIONAL SCIENCE BOARD
NATIONAL SCIENCE FOUNDATION
1969

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FOREWORD

This volume presents the statistical evidence, forward projections, analyses, and interpretations which underlie the conclusions and recommendations offered in the First Report of the National Science Board entitled *Toward a Public Policy for Graduate Education in the Sciences*. However, this is much more than an appendix to that Report. It is both a unique analysis of the present status of graduate education and the source of a large body of information and useful correlations which should be invaluable to rational planning for graduate education and indeed for all of higher education.

Dr. Lawton M. Hartman, the principal author of this volume, selected the relevant data and recast them for use in both documents. However, responsibility for this selection of materials and for their analysis is shared by a Committee of the National Science Board.

In accepting this document, recommending its publication, and generally endorsing its conclusions, the National Science Board hopes that this identification and analysis of issues with respect to graduate education will facilitate and sharpen local, State, national and Federal planning for this vital segment of the education system in the next decade.

Philip Handler

Philip Handler
Chairman, National Science Board

(no p. IV)

PREFACE

This report has been prepared to illustrate many of the circumstances that will determine the character, magnitude, and directions of graduate education, especially in the sciences and engineering, during the next decade in the United States. The information presented, and its interpretation, provides supporting evidence and background for many of the conclusions and recommendations contained in the first report of the National Science Board. This information, however, can be only illustrative, for graduate education today is exceedingly complex, no two institutions are exactly alike, and the scene is continually and rapidly changing in detail.

Although the report has not been addressed to delineation of issues of public policy, many of these issues are implicit in the material reviewed. They include such questions as: Should the projected needs for graduate educational capacity in the United States be met primarily through the formation of new graduate institutions or through the selective development and expansion of existing institutions? In what States and metropolitan areas is additional graduate educational capacity most urgently needed? Can objective criteria be identified to assist in the appraisal of graduate institutional quality? What measures would be appropriate to offset a possible decline in the average quality of graduate education during the next decade? What magnitude of expenditures can be anticipated in support of graduate education during the next ten years? What is the appropriate role of the Federal Government in relation to graduate education and how should this role be exercised?

The intent of this report is to characterize American graduate education as it has existed during the 1960's, considering this decade as the starting point for long-range future developments. Within this period a convenient year for the synchronous appraisal of many aspects of graduate education is fiscal or calendar year 1964. That year marks, for example, the most recent general review of graduate institutional quality; the most recent, complete data, published by the Office of Education, on graduate enrollments; and the most recent general listing, published by the Bureau of the Budget, of Standard Metropolitan Statistical

Areas. No attempt has been made to include the effects, assumed to be temporary, of recent reductions in the Federal funding of academic science.

In Chapter I, *Dimensions of Graduate Education,* some of the salient features of institutional "demography" are presented. This information includes the number of graduate institutions; their types, locations, and transformations; the distribution of graduate enrollments; the numbers and types of degrees awarded; and representative projections to the period 1980-1981.

Chapter II, *Correlates of Quality,* contains a review of a number of factors that appear to be generally associated with the perceived quality either of total institutions or of graduate disciplinary departments. In terms of these factors, graduate institutions of high quality are characterized, the costs of developmental programs to improve quality are estimated, and the geographic distribution of graduate education of high quality is summarized.

In Chapter III, *Financial Perspectives,* important financial patterns and trends in universities are examined, together with several fundamental characteristics of the academic scene that appear to have been the source of serious misunderstandings in the formulation of public policy and the determination of the Federal role in relation to the institutions of graduate education. Particular emphasis is given to the role of research in graduate education, the essential characteristics of academic accounting practice, and the inherent cost of graduate education in relation to higher education as a whole.

The final section, *Summary,* contains a listing of many of the principal conclusions, including especially those having policy import, that can be formed from a review of the material presented in this report. The list is not intended to be exhaustive, but rather to illustrate the kinds of questions that need to be examined in planning for the future of graduate education in the United States.

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Dimensions of Graduate Education

Graduate education in the United States, in the sense of formal education beyond the baccalaureate, has a long history.[1] Its roots antedate by more than a century the formation of the Nation. Significant features of its development are summarized in Figure 1-1. There are four principal phases:

1. Beginning in the middle of the 17th century graduate education characteristically terminated with the award of the master's degree. This degree continued the medieval traditions of Europe, and especially those of England, under which completion of the formal requirements of higher education entailed seven years of study. The doctorate and the master's degree had been equivalent; the former, however, was later adopted as the terminal degree on the Continent, the latter in England. In the earliest period in the United States, therefore, the master's degree represented formal study, occasionally teaching experience, the completion of lan-

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[1] Numerous works treat the history of graduate education in the United States. Among them are:

Walter Crosby Eells, *Degrees in Higher Education*, Washington, The Center for Applied Research in Education, Inc., 1963. Especially useful for the early history of the master's degree.

Richard J. Storr, *The Beginnings of Graduate Education in America*, Chicago, The University of Chicago Press, 1953.

A. Hunter Dupree, *Science in the Federal Government*, Cambridge, Mass., The Belknap Press of Harvard University Press, 1957. pp. 1-24. Discusses early proposals for the establishment of a national university.

Bernard Berelson, *Graduate Education in the United States*, New York, McGraw-Hill Book Company, Inc., 1960. pp. 6-42. Summarizes the period after 1876.

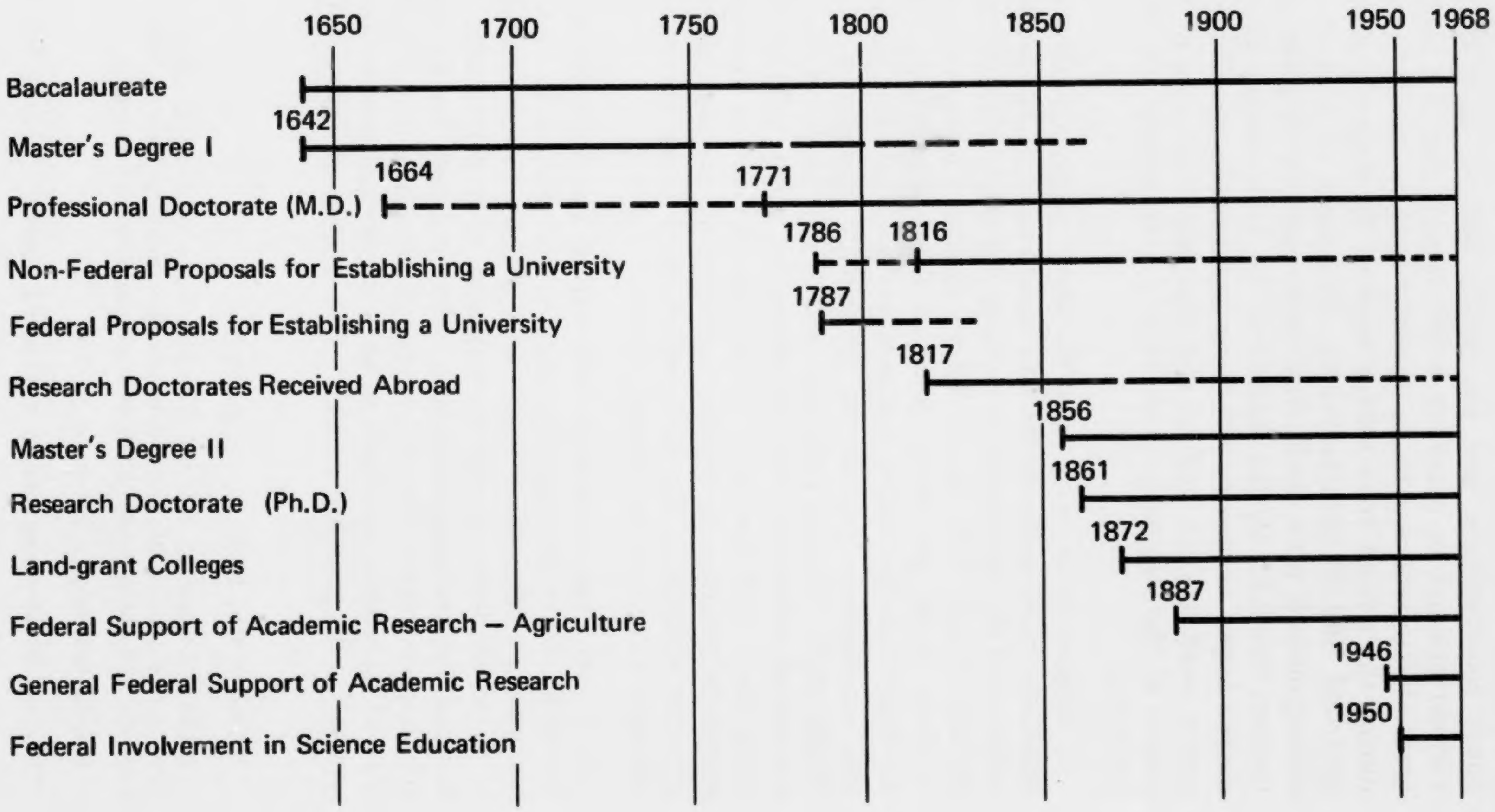
Everett Walters, *The Rise of Graduate Education*, included in *Graduate Education Today*, ed. by Everett Walters, Washington, American Council on Education, 1965. pp. 1-29.

NOTES TO FIGURE 1 - 1

1642	First baccalaureate awarded by Harvard.
1642	Statute of Harvard establishing the requirements for the master's or 2nd degree.
1771	First award of the degree of Doctor of Medicine (M.D.) by the College of Philadelphia (later part of the University of Pennsylvania). The first "Doctor of phissicke and chirurgery" was established by court order and action of the General Assembly of Rhode Island in 1664.
1786	Proposal of Benjamin Rush for the establishment of a public school system in Pennsylvania, extending to a university to be attended by the holders of a bachelor's degree.
1787	First attempts, during the Constitutional Convention, by James Madison and others to provide for the establishment of a national university.
1816	Passage of a resolution by the Virginia legislature resulting several years later in the establishment of the University of Virginia.
1817	Receipt of the first foreign research doctorate (University of Göttingen) by an American.
1856	First award of a rehabilitated master's degree by the University of North Carolina, followed in 1859 by the University of Michigan. Provided for a one year program of formal study and the presentation of a thesis.
1861	First award of a research doctorate (PhD) by Yale.
1872	Passage of the Morrill Act and establishment of the land-grant colleges.
1887	Passage of the Hatch Act and the beginning of direct Federal subvention of research in colleges and universities.
1946	Establishment of the Office of Naval Research and the beginning of large scale Federal support of academic research.
1950	Establishment of the National Science Foundation and the formal involvement of the Federal Government in the support of science education.

Figure 1-1

CHRONOLOGY OF GRADUATE EDUCATION IN THE UNITED STATES



guage requirements, and the public defense of a thesis.[2] The earliest attempt to establish a scholarship for the support of a graduate student was made in 1643.[3] It is interesting to note that during the period 1649-1653 a total of 35 master's degrees was awarded, and 53 baccalaureates, for a ratio of 0.66; in 1968 the corresponding ratio, including both master's degrees and doctorates, was 0.23. By the middle of the 18th century the master's degree began to lose its scholarly significance, residence requirements were relaxed, and for the next hundred years or more the award of the degree became largely a formality and frequently honorary.

2. Beginning as early as 1786 many proposals were made to establish a university, as distinct from a college. The earliest plans envisioned the university as entirely a graduate institution whose students would hold the bachelor's degree. These proposals were of three types: (a) efforts, such as those by Benjamin Rush, to develop State systems of public education, including both colleges and universities, (b) efforts, principally sponsored by George Washington, Thomas Jefferson, and James Madison, to establish a national university, and (c) efforts by many individuals, especially those with first-hand knowledge of German universities, to stimulate reforms in existing colleges by the establishment of graduate divisions. The first and third of these movements ultimately succeeded; the second failed.

3. It has been estimated that during the 19th century about 10,000 students journeyed to Europe, and especially to Germany, for graduate education.[4] Partly as a counter to the annual exodus of these students, partly in response to a continually growing demand for graduate education, many colleges finally undertook graduate programs. The characteristic structure became a German type of university established as a superstructure on an English type of undergraduate college.[5] The degree of Doctor of Philos-

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[2] Walter Crosby Eells, *op. cit.*, pp. 72 ff.

[3] Richard J. Storr, *op. cit.*, p. 2. The gift, made to Harvard, did not retain its identity as a scholarship fund. A similar gift, made to Yale by Bishop George Berkeley, did not produce a stipend adequate for the purpose.

[4] Everett Walters, *op. cit.*, pp. 6, 10.

[5] Bernard Berelson, *op cit.*, pp. 9 ff., and Everett Walters, *op. cit.*, pp. 10 ff.

ophy (Ph.D.), first awarded in the United States in 1861, represented the formal adoption of the German degree.[6] At the same time, it was determined that a single faculty should be responsible for both graduate and undergraduate instruction.[7] The result was the emergence of the distinctly American type of university, combining American and European traditions.[8] That the new type of institution did indeed represent a response to growing demand is seen in Table 1-1. By the end of the 19th century doctorates were being awarded in 26 States and the District of Columbia. Parallel to the growth of doctoral programs was the development of a rejuvenated master's degree.[9] While not the equivalent of the 17th century degree, for the doctorate had become the highest degree, the master's degree after the 1850's again began to represent the successful completion of formal programs of graduate education.

4. The most recent phase of graduate education in the United States began with the major contributions of American scientists during World War II and the growing support thereafter of academic research and science education generally by the Federal Government (See also Chapter III). This phase is little more than twenty years old. It is to the characteristic features of graduate education during this latter period and to the outlook for the next decade that this chapter is addressed.

GRADUATE ENROLLMENTS

The number of students enrolled in graduate education has increased steadily since the formation of graduate institutions in the 19th century.[10] Temporary exceptions to this nearly unbroken period of growth are found chiefly during the course of major wars. Several factors appear to have contributed to the demand for graduate education: (a) a generally increasing undergraduate college-age population, nominally the 18 to 21 year age group, (b) a **de facto** policy, dating from the early years of the Nation, that

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[6] Walter Crosby Eells, *op. cit.*, pp. 20 ff.

[7] See Footnote 5.

[8] Everett Walters, *op cit.*, p. 14. See also Clark Kerr, *The Uses of the University*, Cambridge, Mass., Harvard University Press, 1963, pp. 9-18.

[9] Walter Crosby Eells, *op. cit.*, pp. 76 ff.

Table 1-1

SEQUENCE OF FIRST DOCTORAL AWARDS BY STATES

Year	State	Total States	Year	State	Total States
1861	Connecticut	1	1900	Iowa	28
1866	New York	2	1902	West Virginia	29
1871	Pennsylvania	3	1914	North Dakota	31
1873	Massachusetts	4		Washington	
1875	District of Col.	5	1915	Texas	32
1876	Michigan	6	1922	Arizona	33
1878	Maryland	7	1926	Hawaii	35
1879	New Jersey	10		Oregon	
	Ohio		1929	Oklahoma	36
	Tennessee		1931	Vermont	37
1883	Indiana	13	1934	Florida	38
	Missouri		1940	Georgia	39
	North Carolina		1947	New Mexico	41
1885	California	15		Utah	
	Virginia		1948	Delaware	43
1887	Louisiana	16		Wyoming	
1888	Minnesota	17	1952	Alabama	44
1889	Rhode Island	18	1953	Arkansas	45
1891	South Carolina	19	1955	Alaska	46
1892	Wisconsin	20	1956	Montana	47
1893	Illinois	22	1959	South Dakota	48
	Mississippi		1960	Maine	49
1894	Kentucky	23	1962	Idaho	50
1895	Colorado	24	1964	Nevada	51
1896	Kansas	27			
	Nebraska				
	New Hampshire				

Source: American Council on Education; Office of Education (DHEW).

all citizens should have the opportunity to pursue educational goals to the limits of their ability, and hence a steadily increasing average level of educational attainment in the United States, as evidenced by such items as elementary school enrollments[11] and the literacy level, (c) an increasing propensity by high school graduates to continue into college, as noted below in Figure 1-3, and (d) a rapidly growing technological content of the economy, requiring ever more highly skilled teachers, an expanding scientific basis for technology of all types, and growing numbers of those who can bring advanced training to the service of society.

The growth of the population for three different ages during recent years is illustrated in Figure 1-2. Beginning with the recovery from the Depression in the 1930's the number of those less than one year old increased rapidly, reached a peak in 1961, and declined thereafter.[12] It is possible, therefore, that the number of students entering college (typically 18 years old) may begin to decline after 1979, those entering graduate school (typically 22

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[10] Information contained in this report on enrollments and degrees, as well as projections to 1976-1977, has been obtained principally from the following publications and other issues of each series:

> *Projections of Educational Statistics to 1976-77*, Publication No. OE-10030-67, Washington, Office of Education (DHEW), 1968.
>
> *Digest of Educational Statistics*, 1967 Edition, Publication No. OE-10024-67, Washington, Office of Education (DHEW), 1967.
>
> *Enrollment for Master's and Higher Degrees, Fall 1964*, Publication No. OE-54019-64, Washington, Office of Education (DHEW), 1966.
>
> *Earned Degrees Conferred, 1963-1964*, Publication No. OE-54013-66, Washington, Office of Education (DHEW), 1966.
>
> *Education Directory, 1964-1965, Part 3, Higher Education*, Publication No. OE-50000-65, Washington, Office of Education (DHEW), 1965.

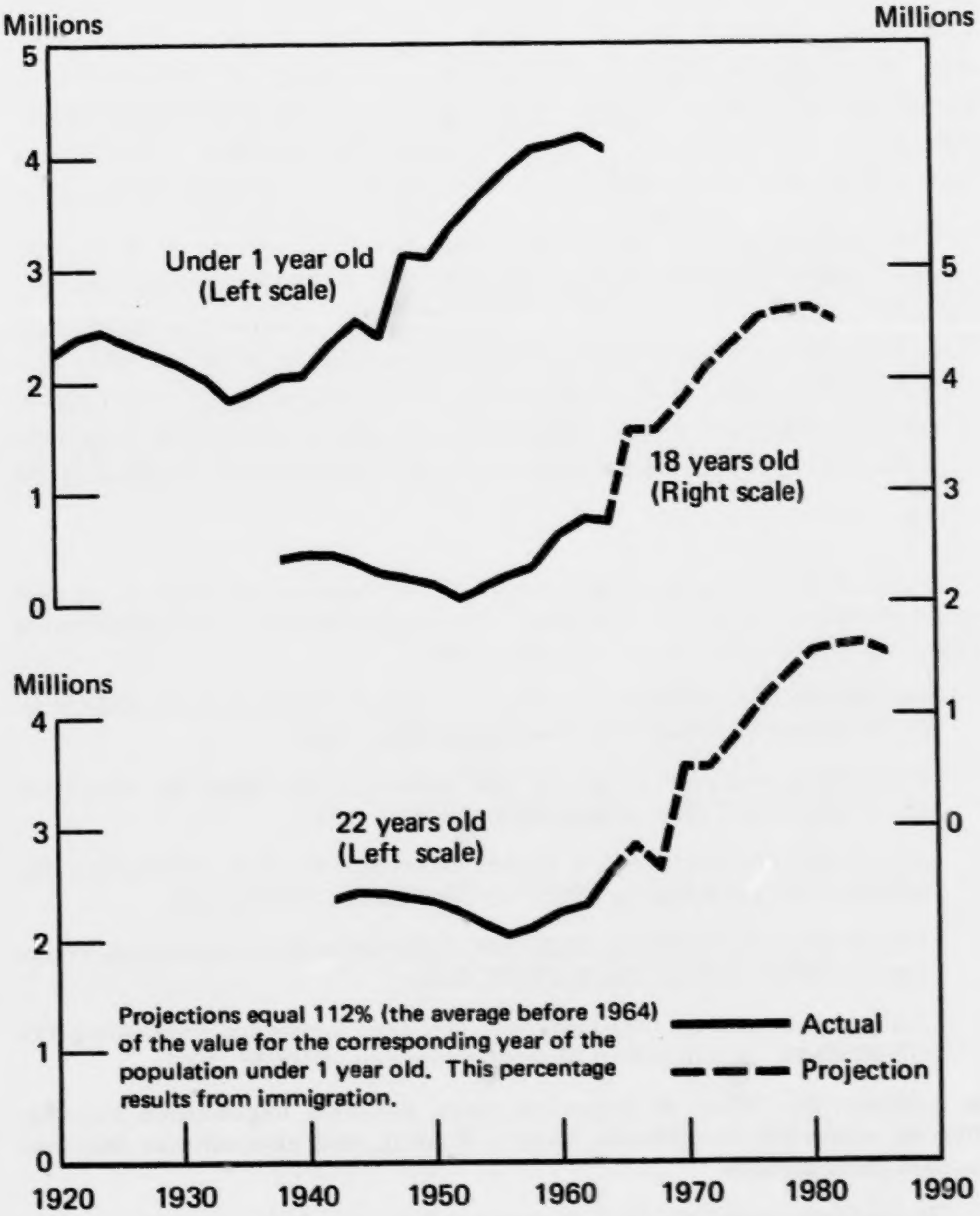
In addition, the Office of Education made available unpublished information on university enrollments, faculty, funding, and expenditures that was used in computations.

[11] In academic year 1869-70, 57.0 percent of the population 5 to 17 years old was enrolled in elementary and secondary schools, a figure that increased to 85.5 percent by 1963-64. Office of Education (DHEW).

[12] The extent of this decline to date is nearly 17 percent in six years, from 4.25 million in 1961 to 3.54 million in 1967 (Bureau of the Census).

Figure 1-2

POPULATION TRENDS FOR DIFFERENT AGES



Projections equal 112% (the average before 1964) of the value for the corresponding year of the population under 1 year old. This percentage results from immigration.

Source: Bureau of the Census

years old) after 1983, **unless** the population trend is offset sufficiently by demand for higher education. However, population growth alone will provide important leverage for graduate enrollments, at least until 1983.

EDUCATIONAL TRENDS

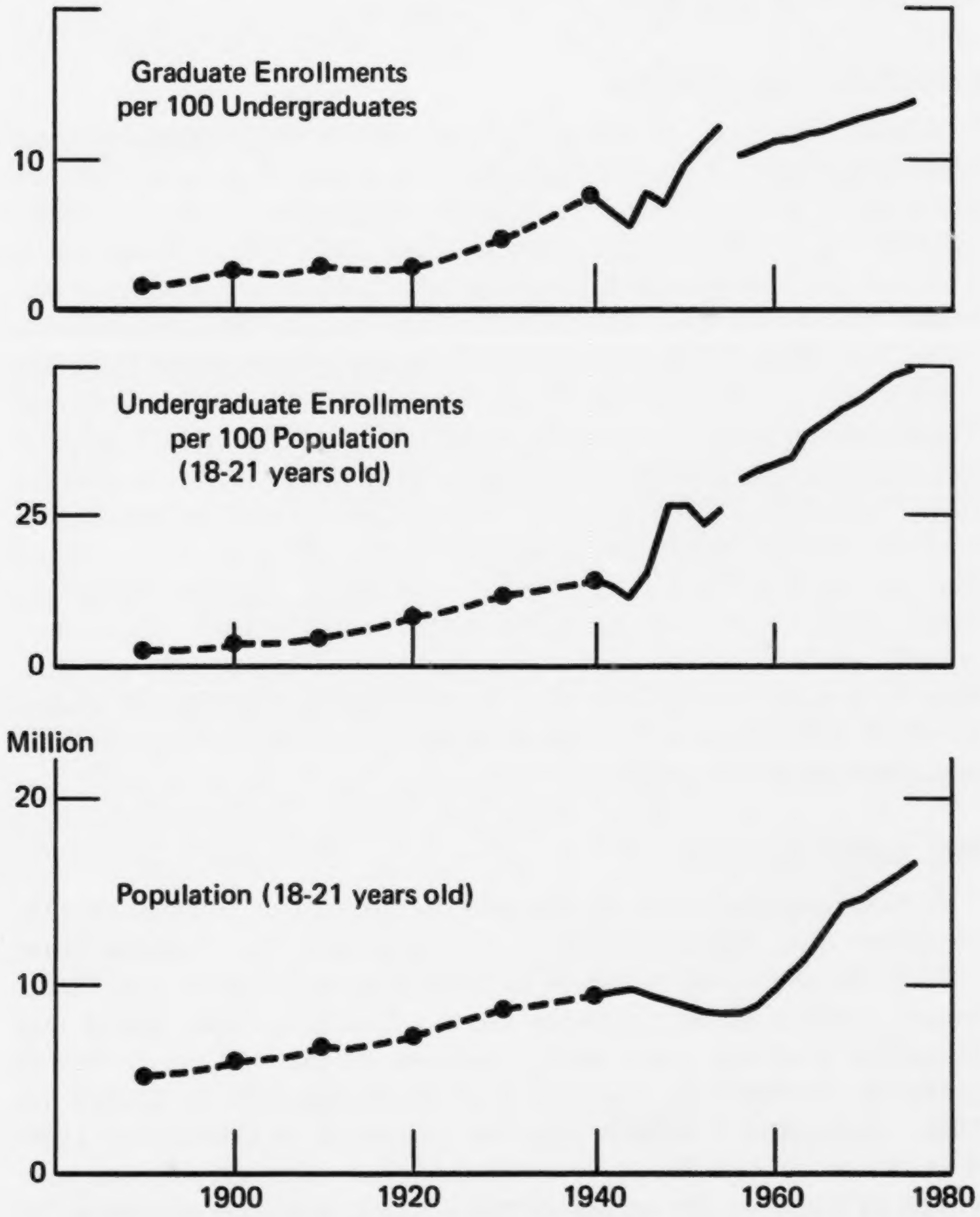
About 77 percent of those 18 years old currently graduate from high school each year, an increase from about 65 percent only 10 years ago. Comparable and continuing long-term trends for undergraduate and graduate enrollments are set forth in Figure 1-3. Thus, at the present time there are about 43 undergraduates, enrolled in resident and extension courses in colleges and universities, for every 100 persons of the 18-21 age group, while there are more than 12 graduate students for every 100 undergraduates. These figures have been achieved after beginning with negligible percentages less than a century ago. Projections indicate that by the Fall of 1976 one-half of the 18-21 age group will be enrolled as undergraduates, while there will be nearly 14 graduate students per 100 undergraduates. Graduate enrollment figures, therefore, result from four simultaneous, reinforcing trends: population growth, completion of elementary and secondary education, decision to proceed to college and successful completion of undergraduate education, and decision to continue after college graduation into advanced study.

THE NEXT DECADE

A more detailed view of the relative growth of population (18-21 years old), undergraduates, and graduate enrollments from 1956 to the projected situation in 1980 is seen in Figure 1-4. These trends confirm those discussed above. The long-term trends and historical doubling times may, however, be misleading. Although graduate enrollments are expected approximately to double by 1980, continuing a pattern that has prevailed at least since 1890, it is far more significant to note that this increase implies provision of capacity for an additional 700,000 graduate students, together with their faculties, libraries, research facilities, and financial support. This **increase** in the number of graduate students is comparable to the **total** college and university enrollment in the United States in the mid-1920's, while the complexity and expense of providing for an effective graduate education is many times that of an undergraduate education. The 1970's thus provide an

Figure 1-3

EDUCATIONAL TRENDS

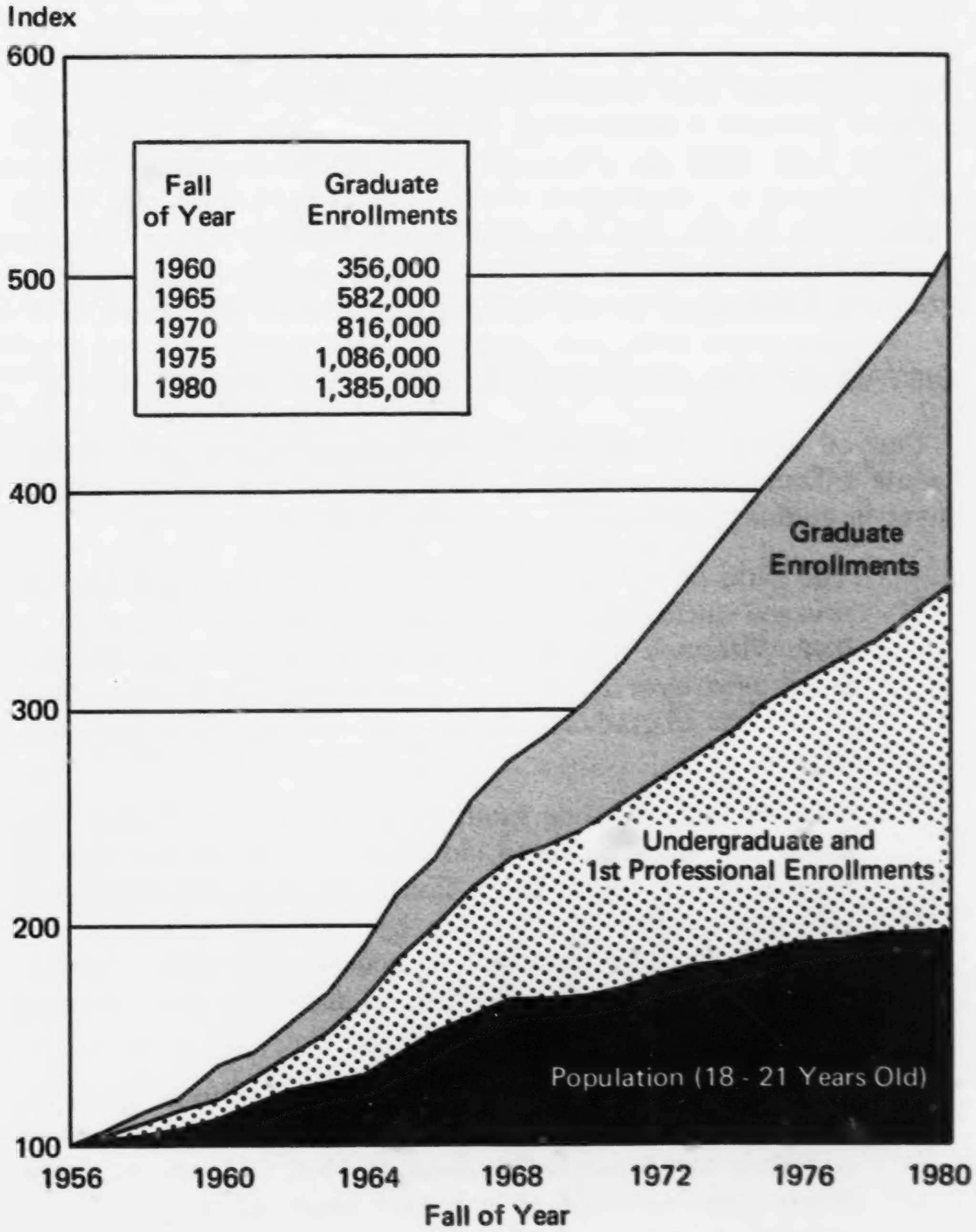


Beginning in 1956 undergraduate enrollments include both resident and extension students. Before 1956 only resident students are included.

Source: Office of Education (DHEW)

Figure 1-4

GROWTH OF GRADUATE ENROLLMENTS



Fall of Year	Graduate Enrollments
1960	356,000
1965	582,000
1970	816,000
1975	1,086,000
1980	1,385,000

The index has been computed by dividing the population (or enrollment) figure for a given year by the value for 1956 and multiplying by 100.

Source: Office of Education (DHEW); projections after 1976 by National Science Foundation.

unprecedented challenge to the resources and to the determination and wisdom of the Nation.

The corresponding **rates** of growth are shown in Figure 1-5. The large annual percentage increase in graduate enrollments during the 1961-65 period corresponds to a doubling time of about 7 years. Although these rates of increase decline to 1980, while their relative position is maintained, there is no basis for projecting a decline in graduate enrollments, even with the anticipated onset of a decline in the population of the 18 to 21 year age group in the early 1980's. In fact, if the trend of growth rates in Figure 1-5 were simply extrapolated, the average annual percentage increase in graduate enrollments would not reach zero until the 1990's.

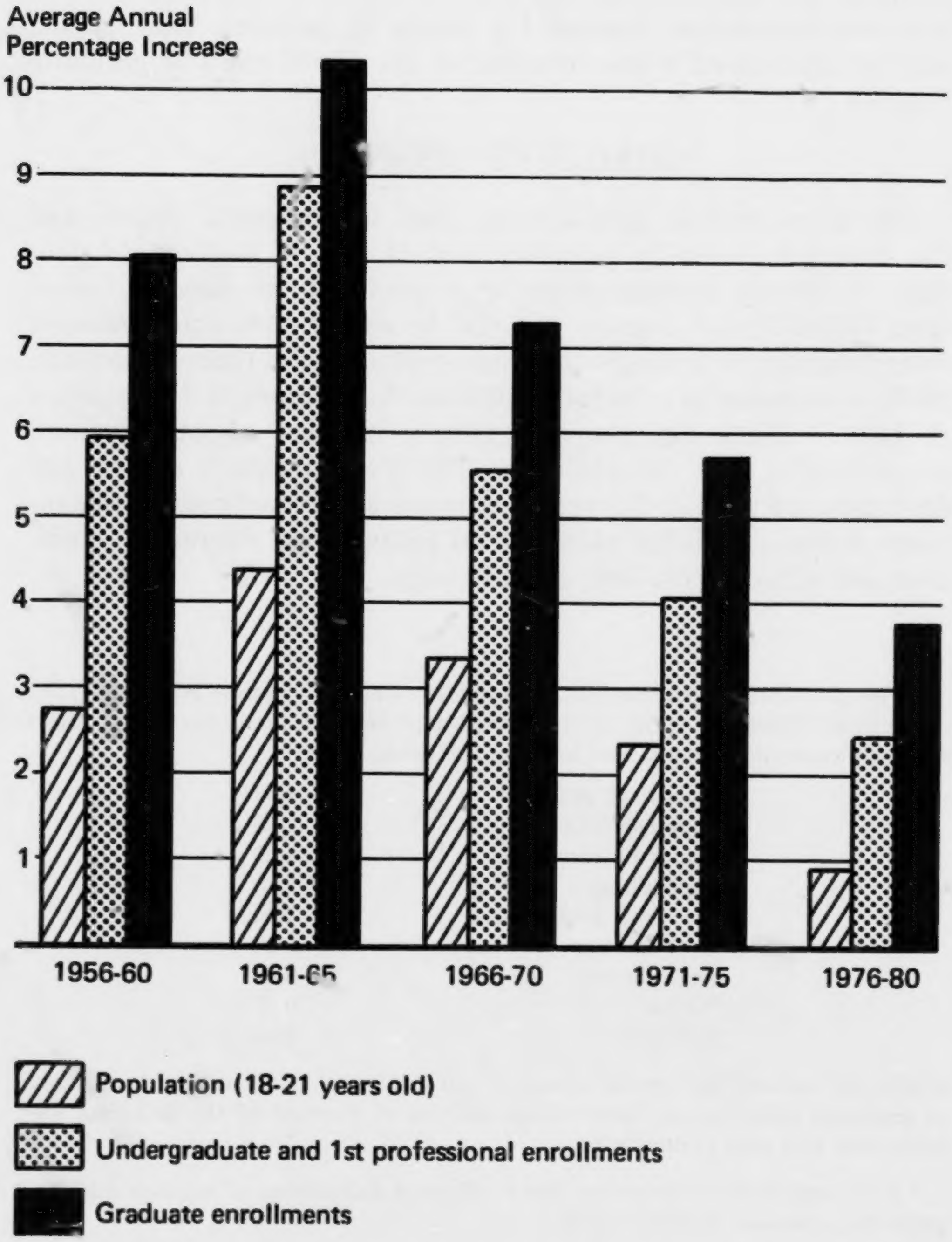
DISTRIBUTIONAL PATTERNS IN GRADUATE ENROLLMENTS

Several distributional trends with respect to graduate enrollments reflect certain structural changes that are slowly taking place in graduate education:

1. The ratio of women to men in graduate education has increased during the decade beginning in 1956 from 0.39 to 0.42. Although this growth is consistent with an increase from zero over a century, during the 1970's more than two-thirds of graduate enrollments will continue to consist of men.
2. The ratio of full-time graduate students to part-time students has also increased slowly, from 0.64 in the Fall of 1956 to 0.77 a decade later. Continuation of this trend will still not achieve parity (1.00) by 1980, an inference that emphasizes the importance of access to graduate institutions by centers of population, a matter to be discussed below.[13]
3. A more rapid growth is exhibited by the ratio of graduate enrollments in publicly controlled institutions to those in privately controlled institutions. In 1956 this ratio was 0.96 (more than one-half of graduate students in private institutions). A decade later this ratio had increased to 1.53 (about 60 percent in public institutions). By 1976 this ratio is projected to increase to 2.22 (69 percent in public institutions).

Figure 1-5

GROWTH RATES OF POPULATION AND ENROLLMENTS



Source: Office of Education (DHEW); projections after 1976 by National Science Foundation.

For the Fall of 1964 the distribution of graduate enrollments by field of study is shown in Figure 1-6. Disciplines have been combined in nine groups. The largest group, Education, represents nearly one-third of all graduate enrollments. The social and natural sciences and engineering, combined, constitute 43 percent.[14] The arts and humanities account for nearly 13 percent. Time trends will be considered below in terms of the distribution of graduate degrees.

GRADUATE DEGREES

The characteristic graduate degrees, the master's degree and the doctorate, actually represent two classes of degrees. In general, including undergraduate and professional degrees, more than 2400 different degrees, denoted by nearly 3000 abbreviations, were awarded by colleges and universities in the United States in 1960, an increase by a factor of 40 from the 60 types in common use in 1887.[15] These degrees vary widely in level of achievement, requirements, and nomenclature. The terms master's degree and doctorate are used in this report to represent earned post-baccalaureate degrees, with the exception of professional degrees in medicine and allied fields, law, and theology.

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[13] The distribution of part-time graduate students varies widely among disciplines. Thus, the ratio of full-time to part-time students for nine groups of disciplines (See Figure 1-6) has the following range:

Biological Sciences	1.98
Physical Sciences	1.65
Social Sciences	1.29
Psychology	1.28
Arts and Humanities	1.14
Mathematics	0.89
Engineering	0.67
"Other"	0.67
Education	0.22

While the natural and social sciences and engineering constitute 43 percent of graduate enrollments, these fields include 56 percent of the full-time enrollments. See also Footnote 14.

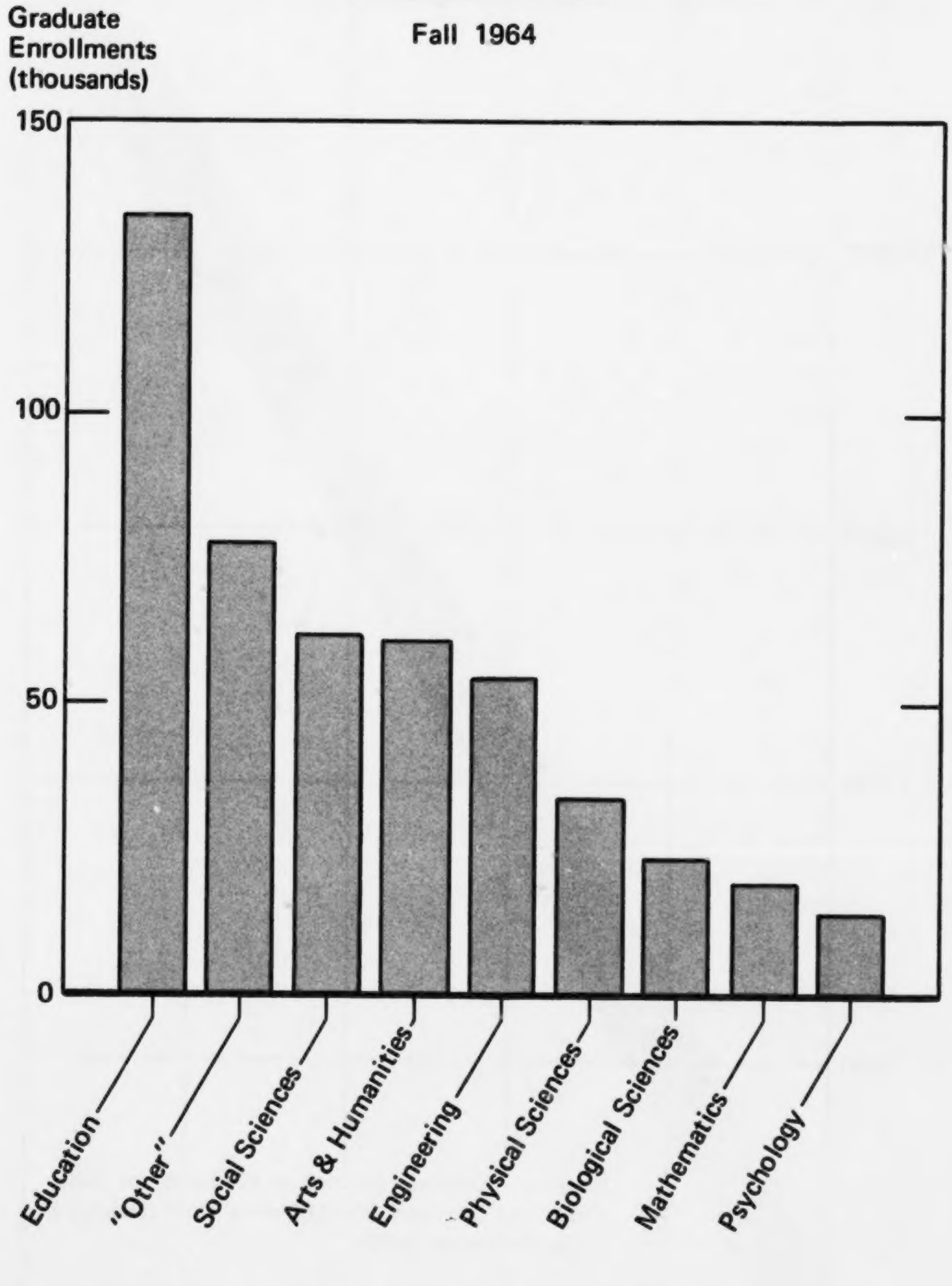
[14] It is important to note that three different definitions of science and engineering are used in this report:

(1) The Office of Education includes history among the social sciences. To maintain consistency in Figures 1-6 and 1-9, together with the

Figure 1-6

DISTRIBUTION OF GRADUATE ENROLLMENTS BY GROUPS OF DISCIPLINES

Fall 1964



Source: Office of Education (DHEW). See Footnote 14.

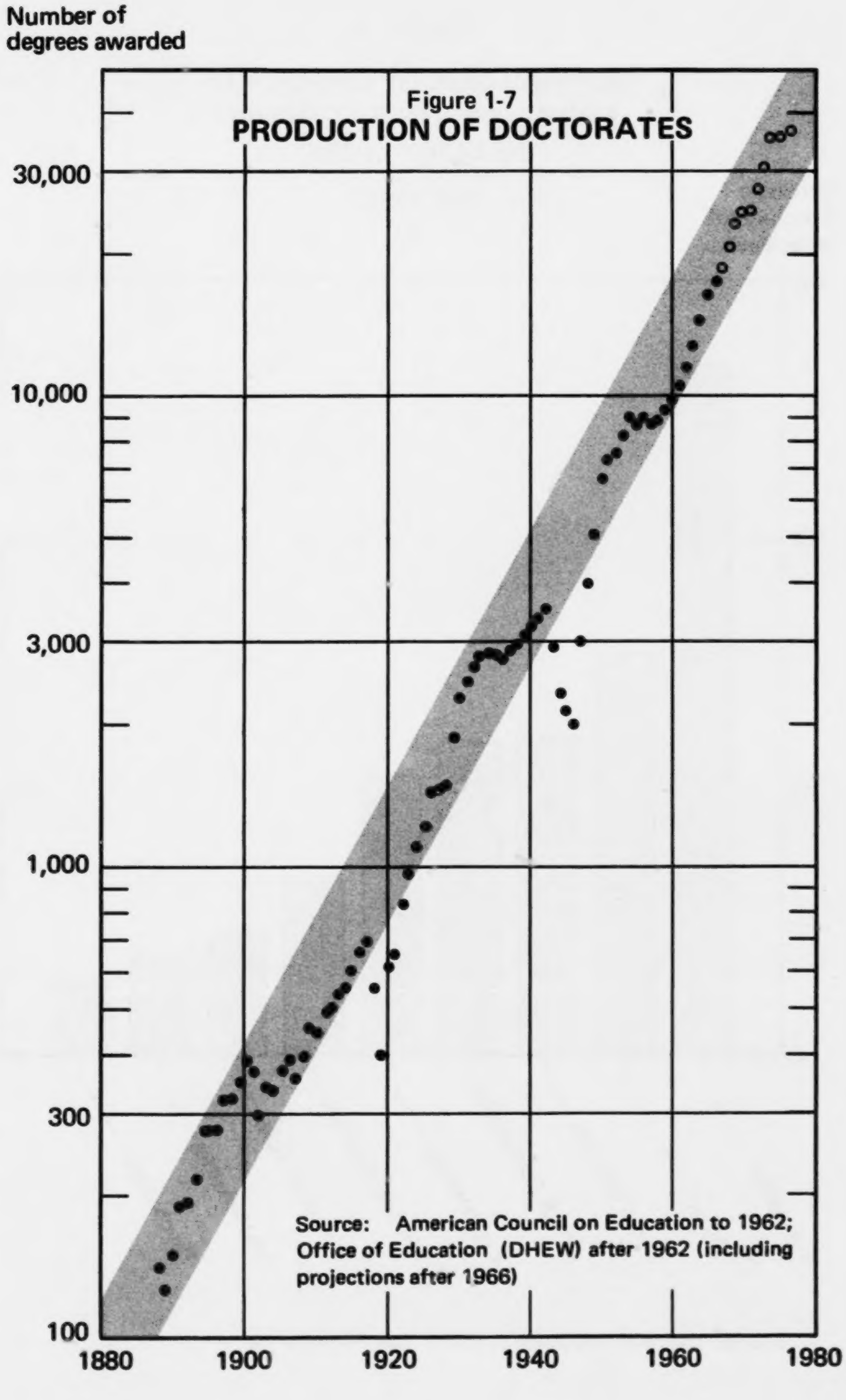


Figure 1-7
PRODUCTION OF DOCTORATES

Source: American Council on Education to 1962; Office of Education (DHEW) after 1962 (including projections after 1966)

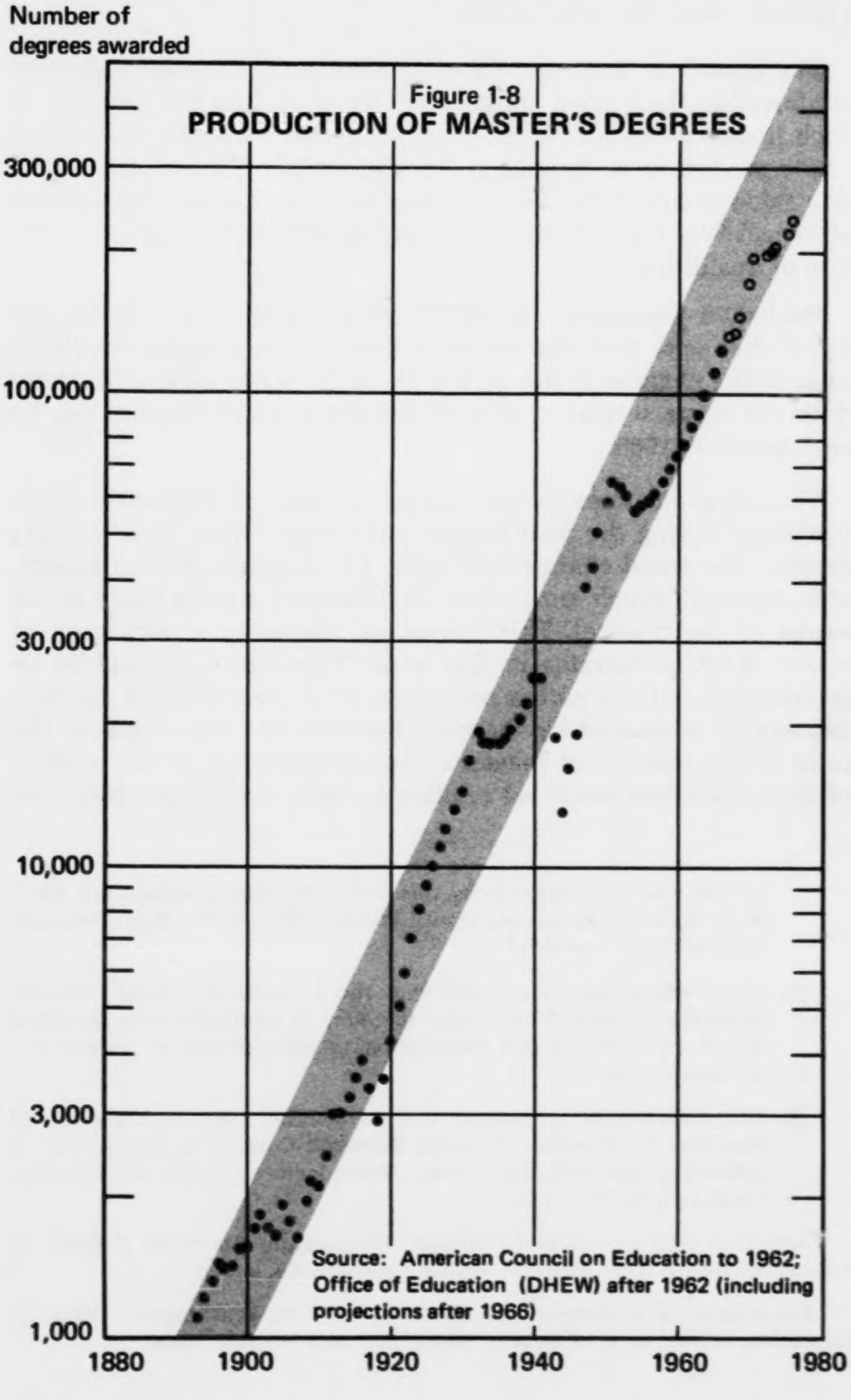


Figure 1-8

PRODUCTION OF MASTER'S DEGREES

Source: American Council on Education to 1962; Office of Education (DHEW) after 1962 (including projections after 1966)

TRENDS AND PROJECTIONS

The growth in the numbers of doctorates and master's degrees conferred in the United States is shown in Figures 1-7 and 1-8. In each instance the annual number of degrees awarded has locked into a well-defined, long-term trend channel. A breakout on the downside occurred for both degrees only during the dislocations of World War I and II, with recovery quickly following the cessation of hostilities.

Published projections to 1977[16] remain within the established trend channels, with the master's degree approaching the lower edge of the channel in the 1970's. If, in the latter case, a breakout does not occur, a total of at least 300,000 master's degrees can be anticipated in 1980.

Various projections of the annual number of doctorates to be conferred during the next decade have been made, with varying results. The trend channel of Figure 1-7 suggests that an acceptable, although rough, projection for 1980-1981 can be made at the **center** of the channel. This procedure results in a projection of about 48,000 doctorates in that year. This figure appears to be generally consistent with a projection of at least 300,000 master's degrees, as suggested by the ratio between the two degrees. The ratio of the number of master's degrees awarded to the number of doctorates has remained relatively stable during the 20th cen-

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growth rates of Figure 1-10, this definition was adopted and leads to the figure of 43 percent above. Without history this figure becomes approximately one-third.

(2) Elsewhere in the report, wherever the expression "science and engineering" is used, figures refer to Office of Education data, modified by the National Science Foundation to transfer history to the arts and humanities.

(3) The classification of science and engineering used by the National Academy of Sciences—National Research Council in its analysis of doctorates also excludes history. Other features of this classification are shown in Table 1-3.

[15] *American Universities and Colleges*, Washington, American Council on Education, 1964, p. 1254. See also Walter Crosby Eells, *op. cit.*

[16] *Projections of Educational Statistics to 1976-77*, Washington, Office of Education, Department of Health, Education, and Welfare, 1968.

Table 1 - 2

RATIO OF MASTER'S DEGREES TO DOCTORATES

Year of Award	Ratio
1880	16.3
1885	13.9
1890	6.8
1895	4.9
1900	4.2
1905	5.2
1910	4.8
1915	5.8
1920	7.0
1925	7.5

Year of Award	Ratio
1930	6.4
1935	6.5
1940	8.1
1945	7.7
1950	8.8
1955	6.6
1960	7.5
1965	6.8
1970	7.0 *
1975	6.2 *

* Projected

Source: American Council on Education and Office of Education (DHEW)

tury, as shown in Table 1-2. During the early period of the establishment of the doctorate in the United States this ratio declined, stabilizing around 4.2 in 1900; thereafter, it gradually rose to a high of about 8.8 in 1950 and has subsequently been in a slowly declining trend. The ratio of 300,000 to 48,000 is 6.2 or the same as the projected 1975 figure. If the 1960 or 1965 ratio prevails, the number of master's degrees would be higher for the projected number of doctorates. In any event, the **internal** evidence does not indicate trend breaks for either degree before 1980-1981, a conclusion that may be modified as the result of events external to the educational system.

Concern has occasionally been expressed over the capacity of the population to provide the numbers of students, in terms of required native intelligence, needed to realize projections of future graduate degrees without gradually reducing standards. That this is not a limiting factor is indicated by a study prepared in 1961[17] on the basis of an analysis of Army General Classification Test scores (average of the general population = 100; average PhD = 130; maximum score = 175). It is estimated that only 1.2 percent of the population with a score of 130 receive doctorates, and only about 19 percent of those with the maximum score of 175. Maintenance of the trend channels would appear to be primarily a matter of opportunity and motivation of students throughout the entire educational process.

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[17] Lindsey R. Harmon, *The High School Backgrounds of Science Doctorates*, Scientific Manpower Report No. 3, Office of Scientific Personnel, National Academy of Sciences-National Research Council, Washington, February 2, 1961.

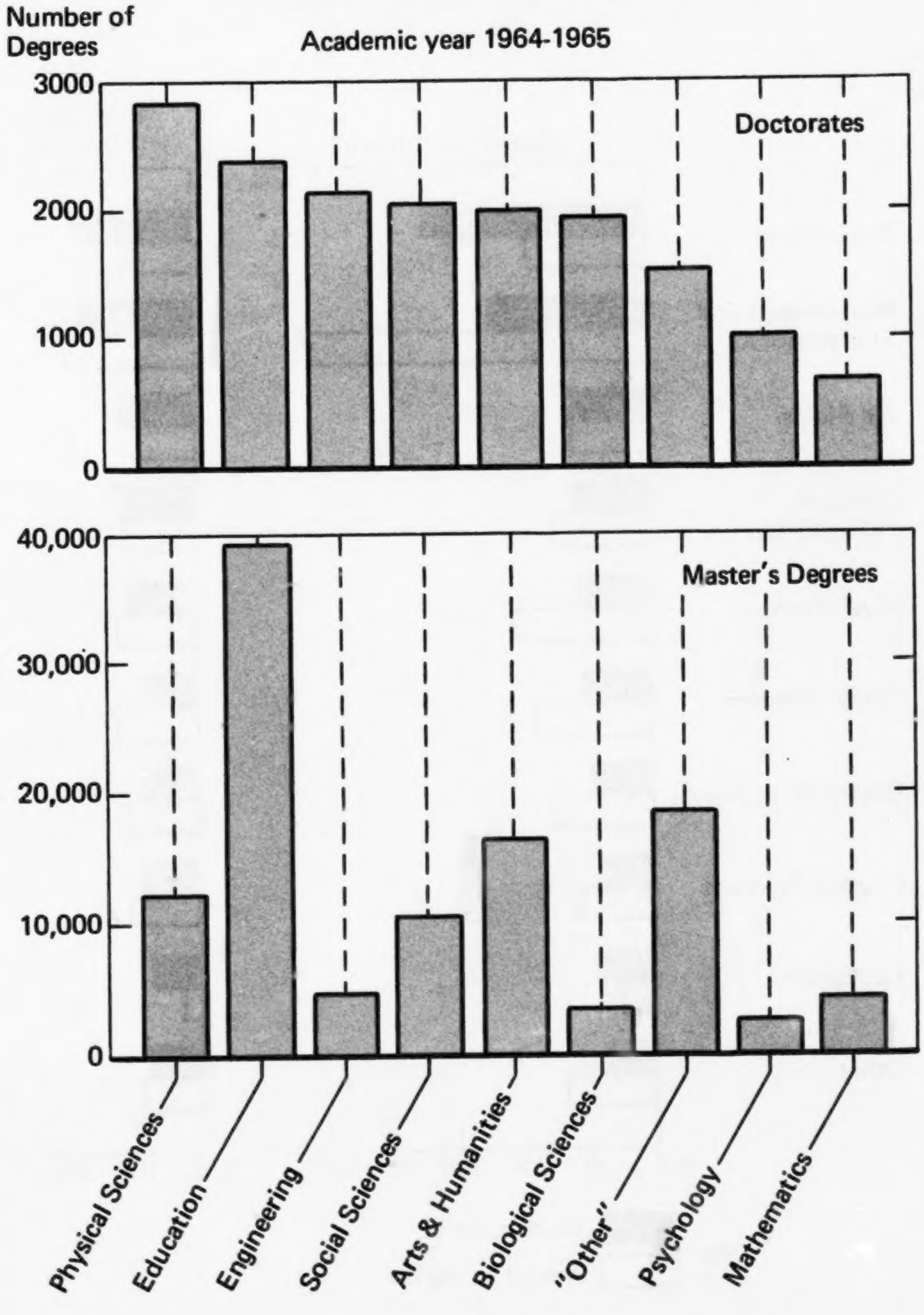
DISTRIBUTION AMONG FIELDS

The distribution of both doctorate and master's degree production for academic year 1964-1965 is shown in Figure 1-9. Degrees have been grouped in nine classes (See Figure 1-6 and Footnote 14); these groups have been arranged in descending order of doctoral output. It will be noted that there is no correlation between number of doctorates awarded and that of master's degrees. Thus the largest source of doctorates, Physical Sciences, is only a moderate source of master's degrees; nearly the reverse is true for the disciplines grouped under "Other." Education, on the other hand, is both the largest source of master's degrees, by far, and the second largest of doctorates. Biological Sciences tends to parallel Physical Sciences, while the pattern for Arts and Humanities is similar to that for Education.

In Figure 1-10 the percentage increases for both types of degrees are shown for the nine groups of disciplines for the ten-year periods from 1956-57 to 1966-67 and from 1966-67 to 1976-77. The groups have been arranged in descending order of percentage increase of doctorates during the earlier period. Actual and projected growth are indicated for both doctorates and master's degrees for each of the groups, but they occur at differing rates. During the past ten years the master's degree growth rate has exceeded that for doctorates for all groups except Engineering and Education; the same is true for the projections, with the addition of Arts and Humanities for which doctoral production is expected to grow faster. The smaller percentages for the period 1966-67 to 1976-77 are consistent with the declining growth rates noted in Figure 1-5.

Figure 1-9

DISTRIBUTION OF GRADUATE DEGREES BY GROUPS OF DISCIPLINES

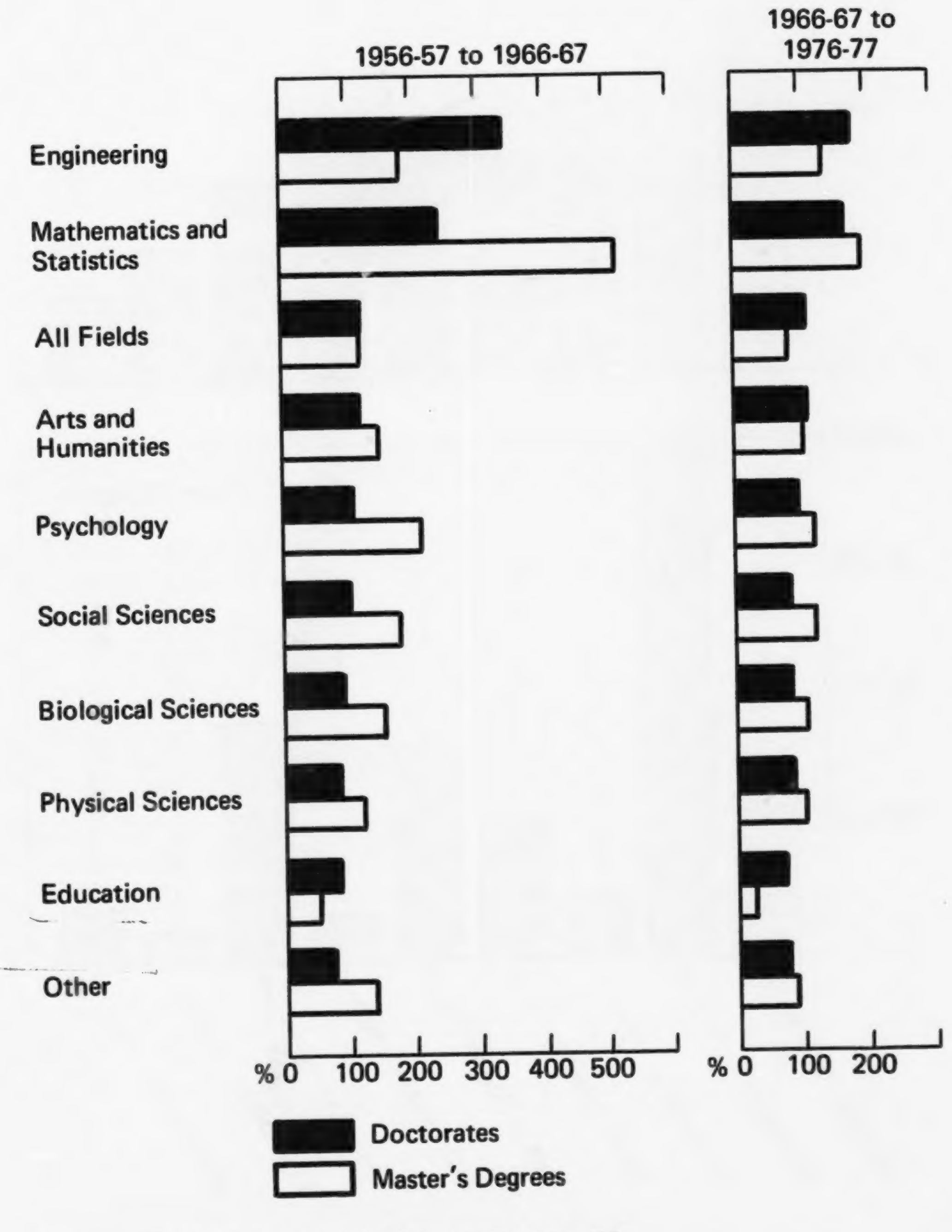


Source: Office of Education (DHEW). See Footnote 14.

Figure 1-10

PERCENTAGE INCREASE OF GRADUATE DEGREE PRODUCTION BY GROUPS OF DISCIPLINES

Actual and Projected



Source: Office of Education (DHEW). See Footnote 14.

ELAPSED TIME FROM BACCALAUREATE TO DOCTORATE

An important dimension of graduate education is the time required by a student, after receiving his bachelor's degree, to complete his work for the doctorate. Clearly it is in the public interest, as well as that of the student, that this phase of his education be completed as expeditiously as possible. In this respect disciplines vary greatly. On the basis of a recent study of those who have received doctorates,[18] there appear to be two principal factors involved in this variation.

The first of these factors relates to the opportunity of the student to proceed without interruption to the completion of his doctoral work. A major contributor to such interruption is lack of adequate financial support for the individual. Hence, unevenness in the availability of support of graduate students would be reflected in variations in the time required to achieve the degree. A measure of this effect is provided in the pattern of Table 1-3 for six groups of disciplines. (These groups differ from those considered previously.) The **total elapsed time** (calendar) between baccalaureate and doctorate increases by a factor of two from Physical Sciences to Education. The **total registered time** in graduate school, however, is more nearly independent of discipline. Confirmation of this effect (i.e., demand for graduate education but inability to attend on a full-time, uninterrupted basis) can also be found in the proportion of graduate enrollments formed by part-time students:

	Part-time Students as a Percentage of Total Enrollments	Elapsed Time (years)—Baccalaureate to Doctorate
Education	82%	13.8
Professional	64	10.8
Arts and Humanities	50	9.5
Social Sciences	42	8.0
Biological Sciences	32	7.3

In this tabulation the Physical Sciences, including Engineering, have been omitted because of the anomalous pattern of Engineer-

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[18] *Doctorate Recipients from United States Universities 1958-1966*, Office of Scientific Personnel, Publication 1489, National Academy of Sciences, Washington, 1967, pp. 64 ff.

Table 1-3

MEDIAN TIME BETWEEN BACCALAUREATE AND DOCTORATE

	FY 1958-60	FY 1961-63	FY 1964-66
Physical Sciences 2/	6.6 yrs. 1/	6.6 yrs.	6.3 yrs.
	4.9	5.0	5.1
Biological Sciences 3/	7.7	7.8	7.3
	5.1	5.2	5.3
Social Sciences 4/	8.7	8.9	8.0
	5.2	5.3	5.3
Arts and Humanities 5/	9.9	10.1	9.5
	5.7	5.7	5.7
Professional 6/	11.3	10.8	10.8
	6.1	5.9	6.0
Education	14.0	13.0	13.8
	6.6	6.6	6.8
All Fields	8.6	8.8	8.2
	5.2	5.3	5.4

1/ First line denotes MEDIAN ELAPSED TIME.
Second line denotes MEDIAN REGISTERED TIME.

2/ Includes engineering and mathematics.

3/ Includes agriculture, forestry, and health sciences.

4/ Includes psychology.

5/ Includes history.

6/ Principally business administration; also includes religion and theology, home economics, etc.

Source: Office of Scientific Personnel, National Academy of Sciences - National Research Council.

ing: a high percentage of part-time students (60%) and a relatively low baccalaureate-doctorate elapsed time (6.9 years). This pattern suggests two distinct groups of engineers: those whose motivation leads to doctoral study, and those who choose to proceed immediately after the baccalaureate to engineering employment, including those who engage in part-time graduate study.

The second factor that contributes to disciplinary variation in elapsed time concerns the institutional and degree **sequence** followed by the recipient of the doctorate. The following pattern has also been noted:[19]

Elapsed Time (years)—Baccalaureate to Doctorate—All Fields	Transfer Pattern
5.4	Baccalaureate and doctorate received at same institution —no master's degree received
5.6	Baccalaureate and doctorate received at different institutions—no master's degree received
7.3	Baccalaureate, master's degree, and doctorate received at same institution
7.5	Baccalaureate received at one institution; both master's degree and doctorate received at a second institution
9.8	Baccalaureate and master's degree received at one institution; doctorate received at a second institution
11.8	Baccalaureate, master's degree, and doctorate received at three different institutions

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[19] *Ibid.*, pp. 53, 77.

Quite apart from the effective loss of time that appears to attend shifting from one institution to another, a major source of variation is seen in this pattern to reside in the disciplinary tradition concerning the intermediate or master's degree. Thus, of 26 disciplines examined, there were no doctorates in 11 who followed the first sequence listed above.[20] Among these disciplines are Education and the Professional fields. Confirmation may thus be sought in the relative magnitude of the master's degree programs:

	Ratio of Master's Degrees to Doctorates (1963-64 to 1965-66)	Elapsed Time (Years)— Baccalaureate to Doctorate
Professional	20.8	10.8
Education	17.0	13.8
Arts and Humanities	8.3	9.5
Social Sciences	4.5	8.0
Physical Sciences	3.9	6.3
Biological Sciences	3.1	7.3

Note: In this tabulation history has been included in social sciences, and Professional relates to degrees in business and commerce, and religion and theology. Otherwise definitions follow Table 1-3.

Again, the position of Physical Sciences is distorted by the inclusion of Engineering. If the latter is omitted the ratio of master's degrees to doctorates becomes 2.7.

GRADUATE INSTITUTIONS

Beginning with the advent of graduate education in the United States, as it is known today, the number of institutions offering graduate programs has continuously increased. During a recent academic year, 1964-1965, the number attained a total of about 700 institutions. In this same year graduate students in the natural and social sciences and engineering were enrolled in 427 of these institutions.

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[20] *Ibid.*, pp. 77 ff.

TYPES OF INSTITUTIONS

Although it has been noted that the characteristic American contribution was the compound university, a combination of German, English, and American traditions, graduate education is actually pursued in many types of institutions. In addition to the multi-departmental universities, with undergraduate, graduate, and professional divisions, graduate students will be found in institutions devoted entirely to graduate work, on the lines of the earlier German model, in specialized institutions such as the institutes of technology, in research institutes, either those that are authorized to award degrees or those that provide research centers for participating degree-granting institutions, in liberal arts colleges that have undertaken limited graduate programs, and others.

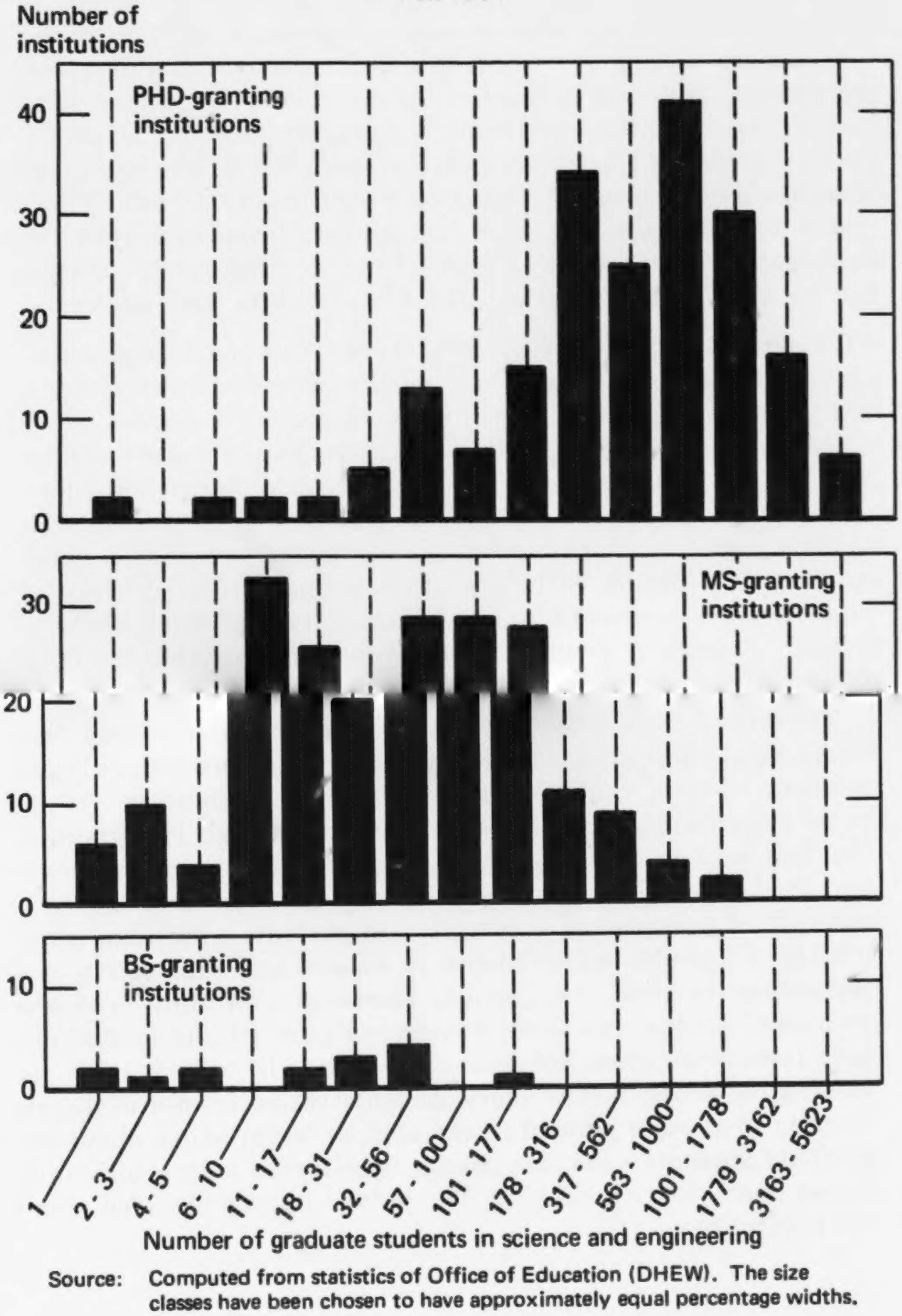
Considering only degree-granting institutions and graduate students in the sciences and engineering, the pattern of institutions—PhD-granting, MS-granting, and BS-granting—with respect to 15 arbitrary size classes, of approximately equal percentage widths based on the number of graduate students, is shown in Figure 1-11. About one-half of the 427 institutions involved awarded the master's degree as the highest degree; a slightly smaller number had programs leading to the doctorate; a small group of 15 institutions did not yet have terminal programs beyond the bachelor's degree, although a number of these institutions had received authorization to grant the master's degree.

The size of the graduate student population varied widely from institution to institution. There were 10 institutions with only one graduate student each in the sciences and engineering. At the other end of the scale there were 6 institutions, all PhD-granting, that had between 3000 and 6000 graduate students each in science and engineering. Parenthetically, it may be noted that the commitment of colleges and universities to graduate education, measured by the graduate enrollments in science and engineering as a percentage of total enrollments, increased uniformly with the number of graduate students, as seen in Figure 1-12. In institutions with fewer than about 500 graduate students in science and engineering the proportion of these students varied from a negligible fraction to about 4 percent of the student body; above about 500 graduate students a distinct change is observed with significantly higher percentages prevailing. The latter category included about 100 institutions.

Figure 1-11

DISTRIBUTION OF GRADUATE ENROLLMENTS IN SCIENCE AND ENGINEERING BY TYPE AND SIZE OF INSTITUTIONS

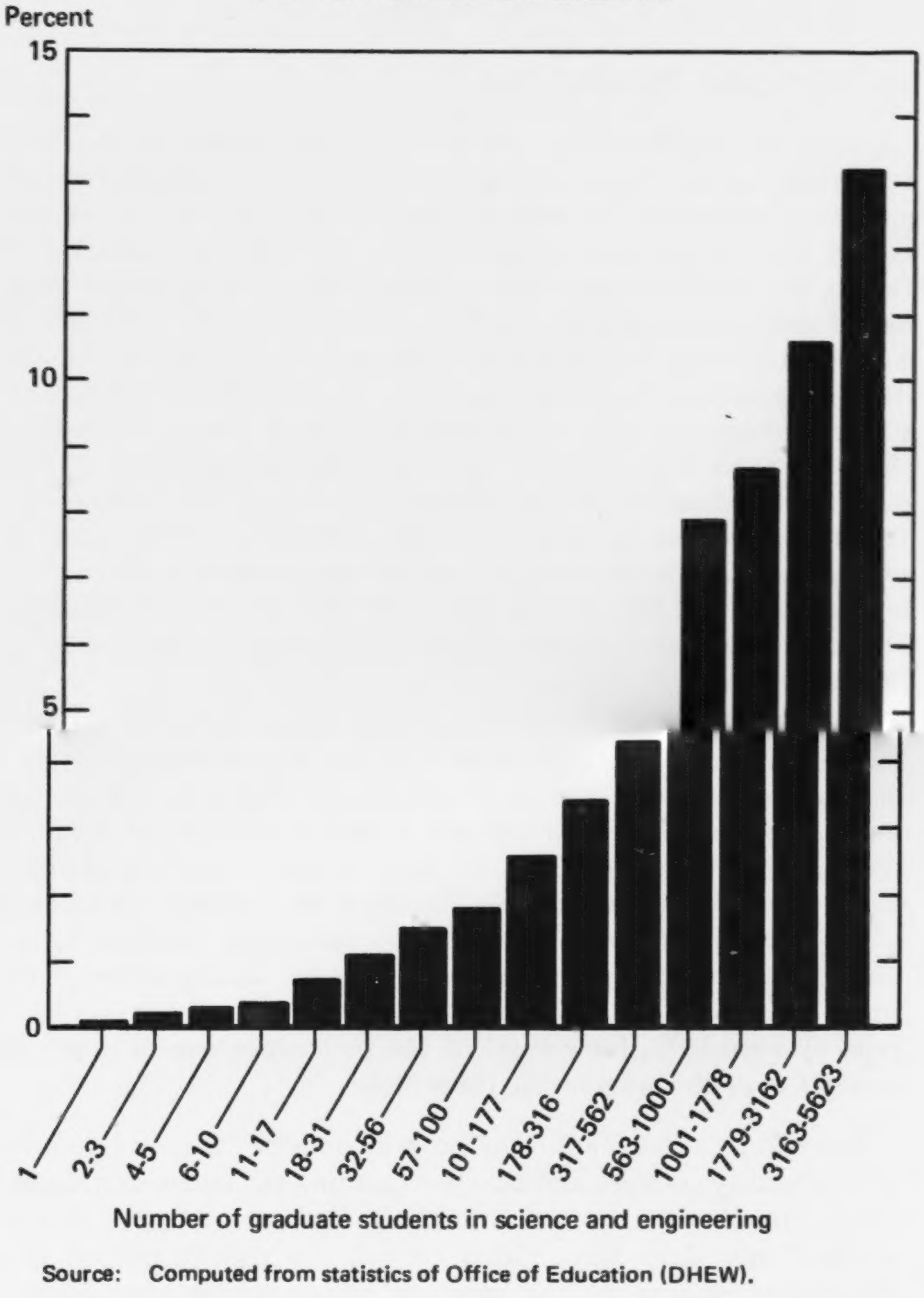
Fall 1964



Source: Computed from statistics of Office of Education (DHEW). The size classes have been chosen to have approximately equal percentage widths.

Figure 1-12

GRADUATE ENROLLMENTS IN SCIENCE AND ENGINEERING AS A PERCENTAGE OF TOTAL ENROLLMENTS



Source: Computed from statistics of Office of Education (DHEW).

Of the total of 427 institutions, more than one-half were under State or other public control, about one-quarter were under private, non-sectarian control, while the remainder, 75 institutions, represented various religious organizations. The distribution is seen in Table 1-4.

INSTITUTIONAL TRANSITIONS

During the century that elapsed since the award of the first doctorates in the United States the number of institutions with programs leading to the doctor's degree increased at an average rate of about 2 per year. More recently this rate has accelerated. During the decade ending with academic year 1965-1966 the number of institutions offering the PhD increased, on the average, by 6.5 per year, while 2 institutions each year have discontinued the doctoral program. The result has been an average net increase of 4.5 institutions per year, as shown in Table 1-5. If it is assumed that this trend will continue, without deliberate attempts to alter it, a total of about 98 additional institutions will have undertaken doctoral programs by academic year 1980-1981, while about 30 will have failed in the attempt, and the net increase will be about 68 for a total in 1980-1981 of about 295 PhD-granting institutions. This represents an increase of about 30 percent over the 1965-1966 total.

A similar situation prevails for those institutions that grant the master's degree as the highest degree. The rate of increase of such institutions, however, has been even greater with a 10-year average net annual increase of 5.6 colleges of this type. The two principal decisions contributing to this net increase have been that of 4-year colleges to proceed to master's programs (an average net increase of 8.1 institutions per year) and the offsetting decision to add doctoral programs (3.7 institutions per year). Continuation of this trend will result in a net increase of about 84 institutions of this type by 1980-1981, for a total of 556 or an increase of nearly 18 percent over the number in 1965-1966.

The two most frequent transitions have been the new formation of community colleges and colleges granting the bachelor's degree. Of all possible transitions involving the four generic types of institutions, only three have not occurred: the transformation of a community college to one granting either master's or doctoral

Table 1 - 4

INSTITUTIONAL DISTRIBUTION OF GRADUATE STUDENTS IN SCIENCE AND ENGINEERING BY TYPE OF CONTROL

Fall 1964

Size Class 1/	Private 2/	Religious	State	Other 3/
1	4	3	3	
2-3	2	5	5	
4-5	5		3	
6-10	9	9	17	
11-17	9	6	14	1
18-31	8	6	14	
32-56	7	12	26	1
57-100	9	3	22	2
101-177	8	6	27	3
178-316	8	14	20	3
317-562	7	4	18	5
563-1000	14	7	22	2
1001-1778	13		18	1
1779-3162	6		9	1
3163-5623	2	—	4	—
	111	75	222	19

1/ See also Figure 1-11 for definition.

2/ Defined as being independent of church and state.

3/ Includes combination private-state control, state-community control, community control, territorial control, and Federal control.

Source: Office of Education (DHEW)

Table 1 - 5

SUMMARY OF INSTITUTIONAL TRANSITIONS

(1956-57 to 1965-66)

Formation of Institutions			
Type	+	-	Net (+)
I	310	151	159
II	267	182	85
III	168	112	56
IV	65	20	45
			345

Frequency of Transitions			
Transition	+	-	Net (+)
0 - I	298	76	222
0 - II	149	45	104
II - III	119	38	81
I - II	75	10	65
III - IV	48	11	37
0 - III	38	24	14
0 - IV	9	4	5
II - IV	8	5	3
I - IV	0	0	0
I - III	0	2	-2
	744	215	

Types: I: Less than 4 years.
II: Awards bachelor's and/or first professional degree.
III: Awards master's and/or second professional degree.
IV: Awards PhD or equivalent.

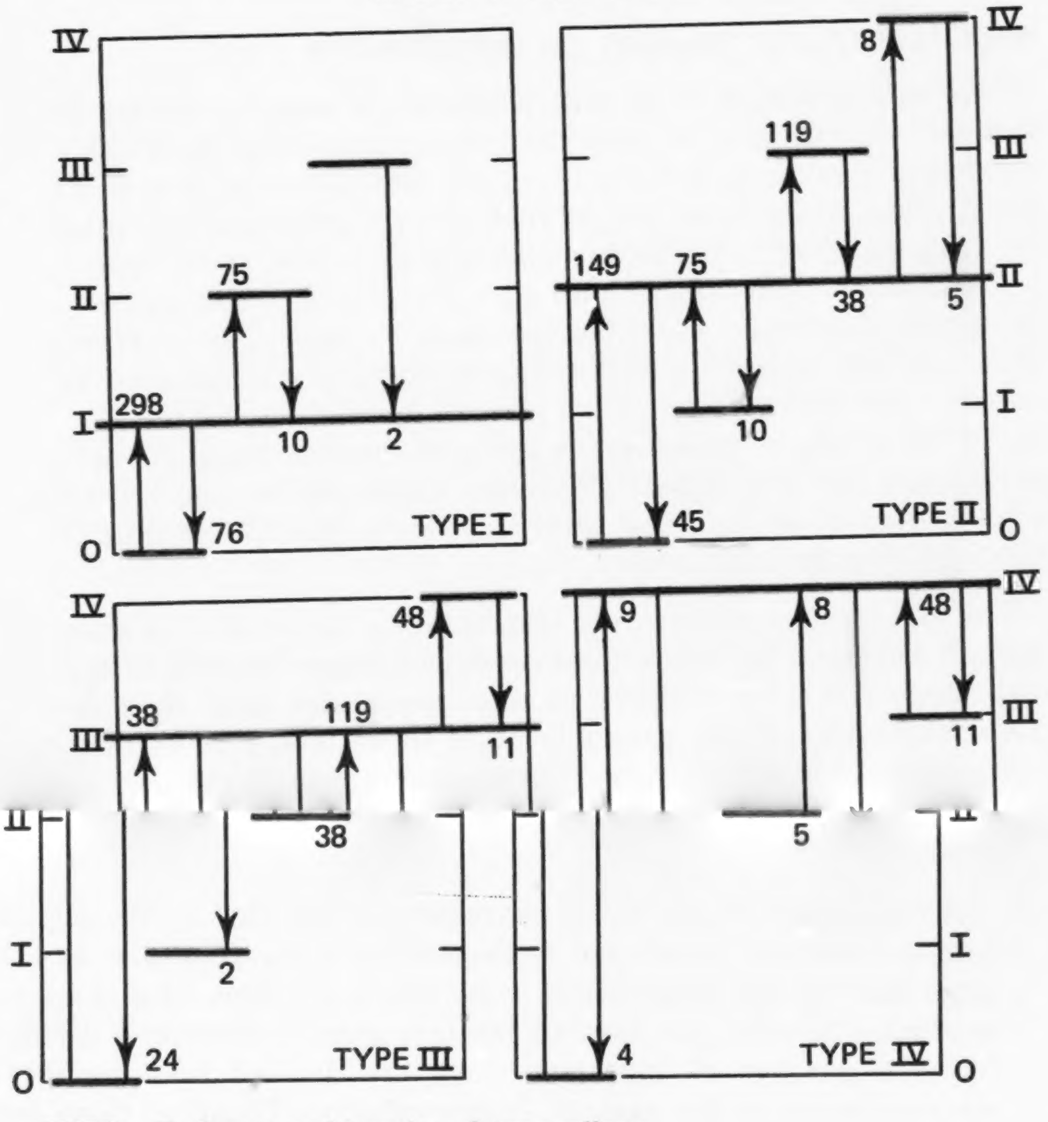
Transition to 0 denotes closing of institution, loss of accreditation, or merger.

Source: Office of Education (DHEW)

Figure 1-13

TRANSITIONS BETWEEN TYPES OF INSTITUTIONS

1956-57 Through 1965-66


IV
III
II
I
O
298
75
10
2
76
TYPE I
149
75
119
8
38
5
10
45
TYPE II
48
38
119
11
38
2
24
TYPE III
9
8
48
11
5
4
TYPE IV

TYPE I 2 year and less than 4 year college

II Grants Bachelor's and/or 1st professional degree

III Grants Master's and/or 2nd professional degree

IV Grants PhD. or equivalent

Transition to O denotes closing of institution, loss of accreditation or merger.

The numbers in the figure denote the number of transitions of the type indicated that occurred over the ten-year period.

Source: Office of Education (DHEW).

degrees and the reverse transition of a PhD-granting institution to a community college. The patterns of transitions that have occurred are illustrated in Figure 1-13.

BACCALAUREATE ORIGINS OF DOCTORATES

Graduate education is ultimately dependent upon its sources of graduate students, that is, upon the undergraduate sources of bachelor's degree holders. These sources are characteristically of three types, respectively those that offer the bachelor's degree, the master's degree, and the doctorate as the highest degree. It is a matter of importance, therefore, to both educational and public policy to determine the relative contributions made by these three sources. Three aspects of such a determination include: (a) the relative output of baccalaureates by each class of institutions, (b) the relative productivity of each class in terms of the fraction of its baccalaureates that subsequently achieves the doctorate, and (c) the achievement of the baccalaureates from each class of institutions after entering graduate school.

The first of these measures is illustrated in Table 1-6. It is seen that the PhD-granting institutions produce a larger fraction of the undergraduates who continue to their doctorates than they do either of baccalaureates generally or of those who receive their baccalaureates in the sciences. The reverse is true of the institutions that award the bachelor's degree as the highest degree, while the master's degree granting institutions occupy an intermediate position.

A conclusion of a different character is suggested by the tabulation in Table 1-7, addressed to the second measure above. In this table the top 100 institutions, considered in terms of a doctoral productivity index (i.e., baccalaureate origins of doctorates divided by total number of baccalaureates), are divided into the three classes, based on the highest degree offering. Together these 100 institutions represent approximately 40 percent of the total baccalaureate output in the sciences and engineering. It is tentatively concluded (a) that there are more bachelor's and master's degree institutions than doctor's degree institutions with a superior record (on this index) of motivating students to continue into doctoral work, and (b) that the performance of these first and intermediate degree institutions is comparable to and even superior to that of the doctoral granting institutions. Considering Tables 1-6 and 1-7 together, it appears that there are, in effect, two groups of institutions that award the bachelor's degree as the highest degree: one that is equivalent in productivity (although, of course, not in size) to the PhD-granting institutions and one that is not.

The third measure is illustrated in Table 1-8. For six groups of disciplines there is little difference in the ability of students from the three types of baccalaureate institutions to achieve their doctorates, with the possible exception of the fields of Education and the Professions (i.e., business administration, the health related professions, home economics, etc.), for which the PhD-granting institutions appear to have the better record.

The important conclusion appears to be that there is a significant group of bachelor's and master's degree granting institutions which, although relatively small in absolute numbers of students, make an effective contribution to the doctoral output of the United States.

GEOGRAPHICAL DISTRIBUTION OF GRADUATE EDUCATION

Since graduate education in the United States has been responsive to the growth of the Nation partly in terms of land area, partly in terms of population growth, and partly in terms of economic development, it is important to examine the present status of graduate education to determine the extent to which it reflects these factors. Of special importance is the relationship to population, for the other factors are strongly influenced by the population base. There are two aspects that need to be considered: the position of the States and the position of metropolitan areas, both existing as loci of population centers with which graduate education can interact.

STATE PATTERNS

In the Fall of 1964 there was an average of about 265 graduate students, including both part-time and full-time students in all fields, per 100,000 persons in the United States. The average for each State is listed in Table 1-9. The States, however, generally clustered about an average line, as shown in Figure 1-14. Largely because of the commitment of California, Massachusetts, Michigan, and New York to graduate education, a total of 35 States

Table 1 - 6

DISTRIBUTION OF BACCALAUREATES AND BACCALAUREATE ORIGINS OF DOCTORATES

Type of Institution	Baccalaureates		Baccalaureate Origins of Doctorates	
	All Fields	Sciences	Natural Sciences	Social Sciences
Bachelor's Granting	26%	23%	13%	13%
Master's Granting	27	24	19	27
Doctor's Granting	47	53	68	60

Source: Analysis of baccalaureates by Office of Economic and Manpower Studies, National Science Foundation; information concerning baccalaureate origins from Office of Scientific Personnel, National Academy of Sciences - National Research Council.

Table 1 - 8

FIVE-YEAR DOCTORAL ACHIEVEMENT OF BACCALAUREATE INSTITUTIONS (1)

	Bachelor's Granting	Master's Granting	Doctor's Granting
Physical Sciences	43%	40%	40%
Biological Sciences	30	31	29
Social Sciences	24	25	25
Arts and Humanities	13	15	15
Professions	7	10	13
Education	3	4	5

(1) Percentage of those receiving doctorate who received this degree within 5 years of receipt of baccalaureate.

Source: National Academy of Sciences - National Research Council

Table 1 - 7

DOCTORAL PRODUCTIVITY OF BACCALAUREATE INSTITUTIONS

The Leading 100 (1)

Type of Institution	Number of Institutions	Average Annual Number of Science Baccalaureates (2)	Baccalaureate Origins of Science Doctorates - Index (3)
Bachelor's Granting	49	46	0.171
Master's Granting	12	136	0.166
Doctor's Granting	39	486	0.155
	100		

(1) Based on the doctoral productivity index (see Note 3).

(2) The average annual number of baccalaureates in the sciences and engineering per institution of the corresponding type during the three academic years 1961-1962 to 1963-1964.

(3) The ratio of the number of baccalaureates awarded that received doctorates in the sciences and engineering during the five academic years 1958-1959 to 1962-1963 to the total number of baccalaureates in the sciences and engineering awarded during the three academic years 1961-1962 to 1963-1964. (See also notes to Figure 2-8).

Source: National Academy of Sciences - National Research Council for baccalaureate origins of doctorates; Office of Education (DHEW) for total baccalaureate awards.

Table 1-9

GRADUATE ENROLLMENTS PER 100,000 POPULATION

Fall 1964

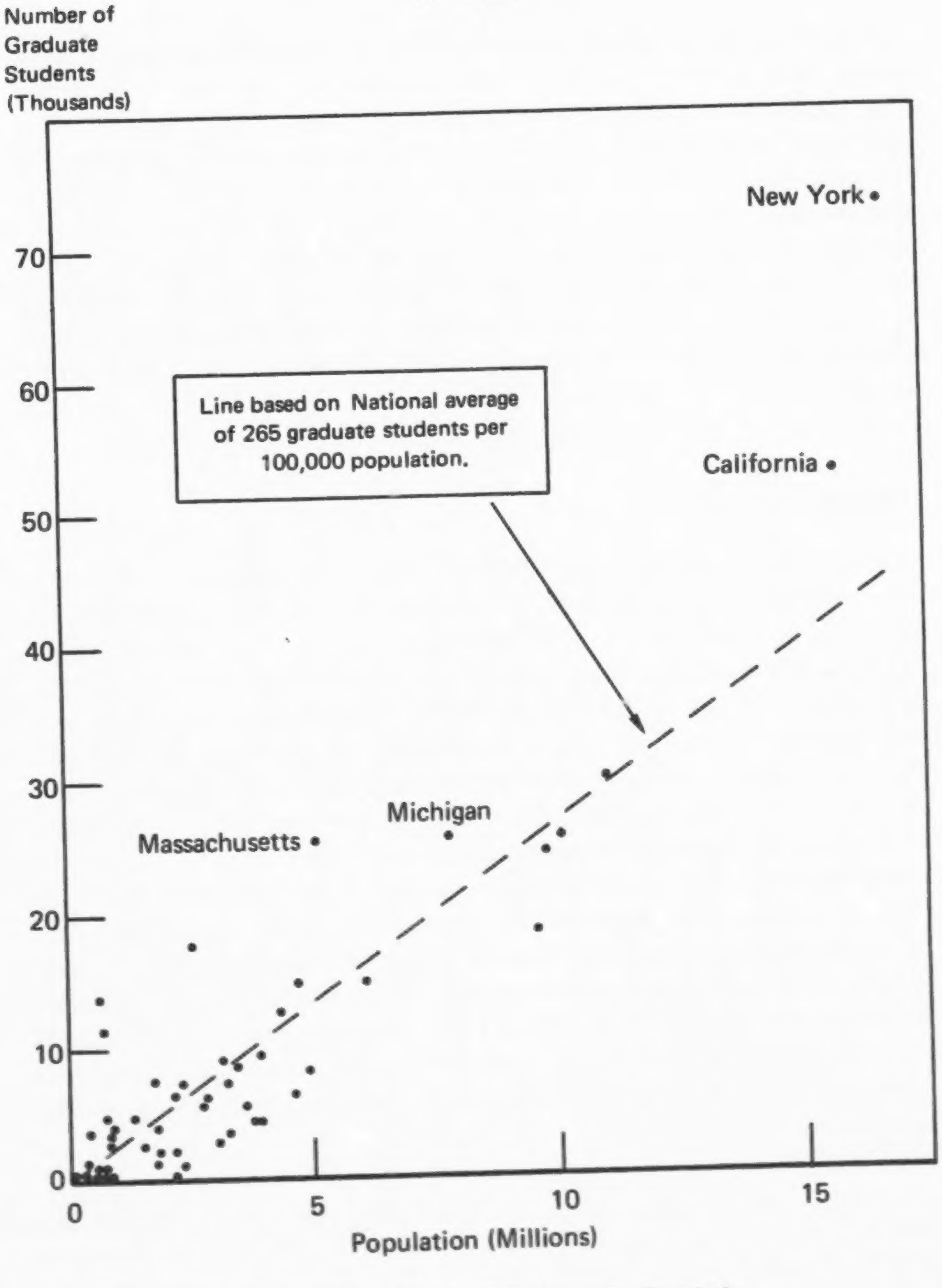
State	Ratio
District of Columbia	1563
Massachusetts	491
Utah	449
Colorado	448
New York	435
Connecticut	425
Arizona	377
Rhode Island	365
California	336
Delaware	334
Michigan	327
Indiana	315
Oklahoma	308
New Mexico	299
Kansas	292
Maryland	292
United States	265
Pennsylvania	264
Minnesota	260
Illinois	251
New Jersey	246
Wisconsin	243
Missouri	238
Oregon	227
New Hampshire	225
Louisiana	224
Washington	214
Iowa	212
Ohio	210
Nebraska	201
Texas	196
Wyoming	176
Florida	168
Tennessee	168
Hawaii	166
North Dakota	160
North Carolina	139
West Virginia	123
Nevada	120
Alabama	114
Georgia	112
Virginia	111
Montana	109
Idaho	108
South Dakota	100
Kentucky	95
Mississippi	93
Vermont	90
Arkansas	85
South Carolina	68
Alaska	58
Maine	50

Source: Office of Education (DHEW); 1960 Census for Population.

Figure 1-14

THE STATE RELATIONSHIP OF POPULATION TO GRADUATE ENROLLMENTS

Fall 1964



Source: Office of Education (DHEW); 1960 Census for Population.

fell below this line. Since the number of graduate students roughly represents the graduate institutional capacity of individual States, the deficit of graduate educational capacity, necessary to bring each State up to the Fall 1964 average, can be estimated for each of these States, as summarized in Table 1-10.

If both graduate enrollments and PhD production are considered, States may be divided into four classes, as illustrated in Table 1-11, defined by national averages. In this figure only graduate enrollments and doctorate output in the sciences and engineering are considered. When concern is expressed over the "equitable distribution" of Federal funds for research and development, the subject should properly be reviewed in the light of this distribution, for the capacity of the individual States to expend markedly increased funds effectively is implied by the distribution. On the other hand, Tables 1-9 and 1-10 help to clarify the appropriate disposition of developmental funding for the expansion and improvement of graduate education in the individual States.

URBAN PATTERNS

Since the immediate benefits to society of graduate education are most directly realized by the interaction of the institution and the local population, an essential parameter of graduate education is the location of graduate institutions. To illustrate this parameter, in Table 1-12 are listed the graduate enrollments in science and engineering, considered as a percentage of all such enrollments, that are located within Standard Metropolitan Statistical Areas[21] in the several States, the District of Columbia, and Puerto Rico. It follows that graduate educational capability that is not so located depends for its contact with societal problems, to the solution of which it is expected to contribute, upon the mobility of graduate students and faculty. If graduate enrollments and PhD production are considered together, the distribution of graduate capability is illustrated in Table 1-13. The importance of this table lies in the identification of specific metropolitan areas that are candidates for the establishment or development of graduate education.

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[21] *Standard Metropolitan Statistical Areas*, prepared by the Office of Statistical Standards, Bureau of the Budget, Executive Office of the President, Washington, 1964.

Table 1 - 10

DEFICITS IN GRADUATE ENROLLMENTS (1)

State	Graduate Students
Texas	6600
Virginia	6100
Georgia	6000
North Carolina	5700
Ohio	5300
Kentucky	5200
Alabama	5000
Florida	4800
South Carolina	4700
Mississippi	3700
Tennessee	3500
Arkansas	3200
West Virginia	2600
Maine	2100
Iowa	1400
Washington	1400
Louisiana	1300
Missouri	1200
New Jersey	1200
Montana	1100
South Dakota	1100
Idaho	1000
Nebraska	900
Wisconsin	900
Oregon	700
Vermont	700
Hawaii	600
North Dakota	600
Alaska	400
Illinois	400
Nevada	400
Wyoming	300
Minnesota	200
New Hampshire	200
Pennsylvania	200

(1) Graduate institutional capacity, in numbers of graduate students, needed to bring the State up to the 1964-1965 national average of 265 graduate students (full-time or part-time) per 100,000 population.

Source: Office of Education (DHEW); 1960 Census for Population.

Table 1-11

GRADUATE ENROLLMENTS AND DOCTORATE AWARDS IN SCIENCE AND ENGINEERING

Distribution of States
(Academic Year 1964-1965)

Graduate Enrollments per 100,000 Population (U.S. Average = 96)	PhD Awards per 1,000,000 Population (U.S. Average = 57)				
	1 - 18	19 - 56	57 - 89	90 - 134	135 or Greater
158 or Greater			Arizona	Colorado Delaware Utah	Massachusetts
125 - 157		New Mexico	California Kansas New York Oklahoma	Rhode Island	
97 - 124		Wyoming	Connecticut Maryland Oregon Washington Wisconsin	Indiana Iowa	
74 - 96		Hawaii Louisiana Missouri New Hampshire New Jersey North Dakota Ohio Pennsylvania Texas	Illinois Michigan Minnesota		
41 - 73	Alabama Idaho Nevada South Dakota Vermont West Virginia	Florida Georgia Montana Nebraska Tennessee Virginia	North Carolina		
1 - 40	Arkansas Kentucky Maine Mississippi South Carolina	Alaska			

Source: Derived from data from the 1960 Census and Office of Education (DHEW).

Table 1 - 12

PERCENTAGE OF GRADUATE STUDENTS IN SCIENCE AND ENGINEERING WITHIN STANDARD METROPOLITAN STATISTICAL AREAS - DISTRIBUTION OF STATES (1)

Fall 1964

Percent		Percent	
100	Delaware	74	Colorado
100	District of Columbia	69	New Jersey
100	Hawaii	69	North Carolina
100	Maryland	68	Georgia
100	Massachusetts	67	Alabama
100	Nevada	59	Connecticut
100	Rhode Island	57	New Mexico
100	Utah	56	Oklahoma
99	Arizona	48	Oregon
99	California	46	Missouri
98	Michigan	45	North Dakota
98	Nebraska	18	Indiana
98	Wisconsin	14	West Virginia
97	South Carolina	12	Florida
94	Illinois	11	Kansas
93	Louisiana	8	Virginia
93	Tennessee	7	Mississippi
92	Kentucky	6	Iowa
91	Minnesota	6	Maine
91	New York	0	Arkansas
91	Ohio	0	Idaho
82	Texas	0	Montana
80	Pennsylvania	0	New Hampshire
79	United States (total)	0	South Dakota
		0	Puerto Rico
78	Washington		

(1) The situation is indeterminate for Alaska, Vermont, and Wyoming since they do not contain SMSA's.

Source: Office of Education (DHEW) and Bureau of the Budget.

Table 1-13

GRADUATE ENROLLMENTS AND DOCTORATE AWARDS IN SCIENCE AND ENGINEERING

Distribution of 55 Metropolitan Areas (Population 500,000 or Greater) (Academic Year 1964-1965)

Graduate Enrollments per 100,000 Population (U.S. Average = 96)	PhD Awards per 1,000,000 Population (U.S. Average = 57)				
	0	1 - 29	30 - 56	57 - 113	114 or Greater
195 or Greater					Albany * Boston * Columbus Denver Minneapolis * Oklahoma City Sacramento San Francisco * San Jose Seattle Syracuse Washington
96 - 194		Akron Dallas	Atlanta Honolulu Jersey City New York Philadelphia Phoenix	Los Angeles * Pittsburgh Providence * Rochester	San Diego
47 - 95	Dayton San Antonio Toledo	Detroit Fort Worth Hartford Milwaukee Newark San Bernardino*	Buffalo Cincinnati Houston New Orleans St. Louis	Baltimore Chicago Cleveland	
1 - 46	Anaheim * Birmingham Indianapolis Memphis Paterson * Portland, Ore. San Juan	Louisville Miami			
0	Gary * Norfolk * Tampa * Youngstown*				

*Standard Metropolitan Statistical Area includes other cities.
Kansas City omitted because of insufficient information.

Source: Derived from data from the 1960 Census, the Bureau of the Budget, and the Office of Education (DHEW).

GRADUATE FACULTY

As noted previously, a characteristic development in the United States has been an institutional faculty responsible for both graduate and undergraduate instruction, rather than separate faculties for the two divisions. Specialization within the faculty, however, makes it possible to identify those members whose efforts are **predominantly associated with the graduate endeavor.** On the basis of a major survey it is estimated that this group comprises about 18 percent of the full-time teaching faculty in United States universities and baccalaureate colleges.[22] A description of the characteristics of the graduate faculty, therefore, is conveniently focused on this group.

The median age of the members of this group lies between 40 and 49. The distribution is:

2%	Under 30 years of age
32	30 to 39
37	40 to 49
20	50 to 59
6	60 to 64
3	65 or older

In terms of faculty rank the largest number hold professorships:

44%	Professors
26	Associate professors
22	Assistant professors
8	Instructors or other

Approximately 73 percent hold the doctorate, as compared to about 51 percent for teaching faculty generally. The distribution of highest educational attainment has the following pattern:

11%	Have had postdoctoral study experience
61	Received doctorate
4	Completed all except dissertation for doctorate
8	Received master's degree
14	Received first professional degree

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[22] Ralph E. Dunham, Patricia S. Wright, and Marjorie O. Chandler, *Teaching Faculty in Universities and Four-Year Colleges, Spring 1963*, Publication No. OE-53022-63, Office of Education, Department of Health, Education, and Welfare, Washington, 1966.

1	Received baccalaureate

(figures do not add to 100% because of rounding)

About 6 percent of the graduate faculty is working for a higher degree, principally for the doctorate.

The **principal** assignment of the members of the graduate faculty is teaching:

77%	Teaching
14	Organized (i.e., Sponsored) Research
4	Administration
4	Other

(figures do not add to 100% because of rounding)

It should be noted that these percentages refer to members of the faculty who are in fact involved in the graduate program. There is, in addition, another group (research professors), including an average of 6.6 percent of the total graduate faculty in the sciences and engineering, that is not involved in the graduate program.[23] The time distribution of the graduate (teaching) faculty has the following composite profile:

32%	Instruction
23	Research
14	Administrative duties
13	Individual student conferences
6	Consulting or research not involved with the institution
4	Public service
7	Other

(figures do not add to 100% because of rounding)

The graduate faculty is highly mobile and participates in a personnel market broader than education. Thus, about 24 percent were employed by different educational institutions the previous year, while 7 percent were not involved in higher education. A total of 27 percent came to their present assignment from private business, self-employment, government (including the military), or not-for-profit organizations. Offers of other positions have been received by 61 percent.

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[23] *Graduate Student Support and Manpower Resources in Graduate Science Education, Fall 1965, Fall 1966* (prepared by Robert H. Linnell), Publication No. NSF 68-13, Washington, National Science Foundation, 1968. p. 60 f.

Projections of future graduate faculty, or teaching faculty generally, or of the sources of such faculty are exceedingly uncertain.[24] There appears to be general agreement, however, that faculty for higher education, while currently in a tight supply situation because of rapid increases of enrollments, will be easily supplied by new doctorates after the mid 1970's.

POSTDOCTORAL STUDENTS

Partly because of the advanced state of knowledge and growing complexity in the sciences and engineering, especially in the physical and biological sciences, and partly because of the availability of research support, it has become increasingly necessary and possible for students to continue in the graduate educational environment after receipt of the doctorate and prior to beginning permanent, professional employment. This development has largely occurred since the end of World War II.[25] Support of these individuals may take several forms: postdoctoral fellowships, university appointments as "research associates" or "senior research associates," occasionally quasi-faculty appointments such as the "research professors" noted above, possibly participation in graduate teaching, etc. Large and growing numbers of these students are foreign.[26] A recent study has found that the ratio of the number of postdoctoral students to that of the full-time graduate faculty in doctorate-granting departments in the Fall of 1966 was 0.175 for all sciences and engineering, with a range from 0.389 for the physical sciences to 0.036 for the social sciences.[27]

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[24] Two studies of this topic include:

Science and Engineering Staff in Universities and Colleges (prepared by Thomas J. Mills and Robert W. Cain), Publication No. NSF 67-11, Washington, National Science Foundation, 1967.

Allan M. Cartter, *Future Faculty: Needs and Resources*, included in *Improving College Teaching*, ed. by C. B. T. Lee, Washington, American Council on Education, 1967. p. 135.

[25] See for example *Chemistry: Opportunities and Needs*, Washington, National Academy of Sciences—National Research Council, 1965. pp. 178 f.

[26] *Ibid.*, p. 178. See also *Physics: Survey and Outlook*, Washington, National Academy of Sciences—National Research Council, 1966, p. 19, for statistics concerning the growing numbers and percentages of foreign postdoctoral personnel in physics.

The growing importance of the postdoctoral student as an element of the graduate educational scene deserves special attention, and note should be made of a study devoted to this topic, currently nearing completion under the auspices of the National Academy of Sciences-National Research Council. The postdoctoral experience constitutes an essential extension of the graduate program, especially in the sciences and engineering and especially for those who are planning careers in basic research and university teaching. The graduate student frequently conducts his research as a member of a project team that includes members of the faculty and other graduate students; his terminal year is almost invariably dominated by the schedule commitments of the degree-granting process. A postdoctoral appointment thus often represents his first genuine opportunity for independent research and study, unencumbered by the formal framework of courses, examinations, and the other requirements of graduate work. Further, it often provides his first opportunity to teach advanced courses and thereby to interact with graduate students and contribute to the tutorial environment of the graduate program. A relatively new but increasingly vital part of the education particularly of research scientists and engineers, the postdoctoral period warrants extensive study and recognition as a significant dimension of graduate education.

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[27] *Graduate Student Support and Manpower Resources in Graduate Science Education, op. cit.*, pp. 61 ff.

II

Correlates of Quality

The patterns of graduate education, examined in Chapter I, relate to the number and types of graduate institutions, their historical development and present capacity, their location with respect to centers of population, and projections of future need. Together these patterns define a serious quantitative challenge to graduate education in the United States. To meet only this challenge, however, is insufficient to ensure the success of graduate education in its service to society. Far more important is the quality of the graduate enterprise itself. If a student who lacks essential qualifications is admitted to a graduate or professional school, if the educational environment of the student is deficient in terms of resources or intellectual excitement, if student and teacher together pursue research goals of an unworthy or pedestrian character, if the problems of the modern world are attacked with less than the best of current knowledge and understanding, in short, if society is led to accept a substitute for high quality, then the Nation will suffer.

Few would disagree with this proposition. Yet, to state it is to raise a question of great difficulty, for quality, *per se*, cannot be measured, nor can a simplistic prescription be devised for the achievement of high quality. Quality can only be determined through the process of informed judgment. It frequently takes the form of a ranking based upon a comparison of relative merit. Where such a judgment has been made, however, and where an ordering or ranking of institutions has been constructed and can form the basis for further study, it is possible to examine some of the characteristics of institutions of high quality. If the resulting patterns are generally consistent, and if they lend themselves to reasonable interpretation, confidence in the initial judgment is increased. At the same time, there emerges a description of an institution of high quality, as contrasted with one of poor quality, and this description may be useful to those responsible for planning and administering graduate education. Further inference, however, is not attempted here, for it cannot be concluded that high quality will automatically be achieved through adherence to such a description.

In the following analysis several factors have been identified that appear to have causative implications; in the majority of instances, however, the factors examined simply exhibit the effects of high quality. Although forming only a small part of a full description of an educational institution, these factors illustrate a general conclusion, namely, that **quality is a property of the total institution.** As in other contexts where quality is evaluated, the various elements of an institution are not necessarily uniform in quality. Nevertheless, on balance, a component of high quality can be expected to flourish best within an environment of high quality. This conclusion is especially important with reference to attempts to improve the quality of graduate education or to establish new graduate programs; it is indeed the very essence of the challenge in such an endeavor.

TESTING PROCEDURE

In order to determine whether or not a clear relationship can be identified between institutional quality and a characteristic of the institution, it has been necessary to adopt a scale of quality to serve as a common standard for comparison. The construction of such a scale has been facilitated by a recent study addressed to quality in graduate education.[1] Although controversial in detail, inevitably the case in an evaluation of quality, this study rests upon a large scale compendium of peer judgments. It thus conforms to the essential feature of such an evaluation, namely, that it be based upon informed judgment.[2] To accept the results of this study for further analytical purposes, and thereby to avoid the unanswerable question of whether they are "correct" or not, is to place the burden of proof on the consistency of patterns resulting from an examination of many factors. It is sufficient, therefore, that the rankings developed in this reference study have been carefully examined to ensure (a) that the effects of obvious sources of bias or uncertainty are small and (b) that statistical tests of reliability are satisfied.[3]

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[1] Allan M. Cartter, *An Assessment of Quality in Graduate Education*, Washington, American Council on Education, 1966. An evaluation of graduate departments in 29 academic disciplines (including natural and social sciences, engineering, and humanities) in 106 institutions (those that had awarded 100 or more doctorates in three or more fields during the 1953-1962 period, or that were members of the Council of Graduate Schools in 1961). This study has been chosen for the purposes of this report for several reasons: (a) it is the most recent study of its kind; (b) it includes a larger number of universities than have previous surveys conducted since 1924; (c) it includes a larger number of disciplines and is based upon the judgments of a larger number of respondents than has been the case previously; and (d), because of the analytic treatment of survey data, it can be used objectively for classification and the construction of composite scales.

This study of quality in graduate education has implicitly recognized the academic department as the largest subdivision of a university that can appropriately be subjected to the procedures of peer judgment.[4] It has thus been necessary, in order to utilize the results of this study for the appraisal of institution-wide factors as possible correlates of institutional quality, to devise a composite rating of total graduate institutions. This has been accomplished in the following manner. The Cartter study placed each graduate department in one of five arbitrarily delimited classes: **distinguished, strong, good, adequate,** and others that are either marginal in quality or insufficient to offer adequate doctoral training. To obtain a composite institutional rating for the purposes of this report, points have been assigned to each of these classes, a composite point value has been computed for each institution, and the resulting point range for 106 institutions has been subdivided into seven quality classes. The seven classes do **not** contain equal numbers of institutions. In order of descending quality these classes are denoted in this report as:

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[2] *Ibid.* The study reports the combined judgments of 4,008 respondents whose names had been submitted by the graduate deans of the participating institutions. These individuals expressed their evaluations of (a) the quality of the graduate faculty and (b) the effectiveness of the graduate program of each department in their respective specialties that had granted at least one doctorate during the preceding decade. The results of the first of these two evaluations have been used in this report.

[3] *Ibid.*, pp. 5-9, 78-105, 124-125.

[4] The Cartter study specifically avoids the identification of aggregate or composite ratings for each of the universities of the sample. Such aggregates are computed and used for analytical purposes, without, however, identifying individual institutions. *Ibid.*, pp. 106 ff.

Quality Class: A, B, C, D, E, F, G

In order to avoid reconstruction and hence identification of the class assignment of each institution, the method used for assigning points and subdividing into classes, will not be described. This omission does not limit the usefulness of the classification, however, since the purpose of this analysis is to examine the patterns exhibited by potential correlates of quality, not the characteristics of individual institutions.

It should be noted that precision has not been sought in the use of either departmental or composite point values, especially since it is not clear what "precision" would signify in the absence of valid or meaningful judgments of total institutional quality. Instead, the **class** assignments of the Cartter study have been used to determine the **class** assignments of total institutions. Thus no further distinction is made between institutions assigned to the same quality class.

Several additional requirements have suggested the procedure that has been adopted for this report:

1. It has been deemed appropriate to minimize the effect of debatable assignments of individual institutions to quality classes, especially marginal cases of institutions that lie near the boundaries separating adjacent classes.
2. Wide ranges of values prevail among the institutions of each quality class with respect to many of the factors that have been examined. Since it is important that equal weight be given to each of these institutions, in order to uncover possible characteristics of the class as a whole, the computation of averages has been avoided. (See also Footnote 5)
3. In several instances specific factors are not applicable to one or more individual institutions or, alternatively, these institutions have not reported data in the surveys chosen for this review. The procedure should not be sensitive to the elimination of one or two of these institutions from a single quality class.

Accordingly the following procedure has been chosen for the purpose of this report:

> The median value of a factor, computed for each of the institutions comprising a quality class, is taken to be representative of the class. If the medians for the seven quality classes, with only at most one or two exceptions, form a uniformly increasing or decreasing sequence, it is concluded that the factor in question is a correlate of graduate institutional quality.

This procedure leads to a simple graphical presentation in which the behavior and significance of a factor is readily apparent.[5]

CLASSES OF FACTORS

In principle, any quantifiable feature of an institution is potentially a correlate of institutional quality. It should thus be tested and interpreted. Although the number of such features may be almost unlimited, those selected for this report have been chosen as being generally illustrative of (a) broad institutional characteristics, (b) operational results of institutional activities, (c) institutional policies that affect operations, and (d) the public response, especially that of either the students or the public generally, to institutional quality. These features of the institution thus serve to illustrate the way in which its quality becomes an attribute of the whole, rather than that of only a single division or school or set of programs.

Many of these factors are mutually related. To the extent that cause and effect, participation and response, and policy and operations are represented, a general overview of institutional quality can be obtained. The development of a set of independent factors, however, suitable either for analytical purposes or for the formulation of public policy, is beyond the scope of this report.

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[5] For the purposes of this report a formal statistical treatment of significance has not been invoked. Although the values for a factor generally tended to cluster for the institutions of a single quality class, wide excursions were occasionally observed for one or more individual institutions. The median was thus considered to be a more representative measure of the **class** than the average. On the other hand, no single institutional characteristic is sufficient for the appraisal of quality. Hence, consistency of pattern has been sought as the test of significance. To anticipate the results shown below, it may be noted that Classes A, B, C, and D present a uniform sequence for 19 of the 20 factors considered. It is not claimed, however, that small differences between medians are necessarily significant.

Several types of potential correlates have been omitted from this review. Either these factors appear to be defective and likely to be misinterpreted, or they are not, upon examination, satisfactory correlates of quality, or information is currently lacking to permit their appraisal. Typical of this group of factors are the following:

1. The number or percentage of faculty members who hold the doctorate is generally regarded as a correlate of graduate educational quality. However, this factor is dependent upon the mix and traditions of individual disciplines.[6] It would also be difficult to replace this factor by a "highest degree appropriate to the discipline" criterion, a definition that is occasionally used by universities in reporting their faculty. The nature of this "highest degree" is furthermore continually changing; an example is provided by the rapid

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[6] An estimate of this effect can be formed from survey data reported in *Teaching Faculty in Universities and 4-Year Colleges, Spring 1963*, Publication No. OE-53022-63, Washington, Office of Education (DHEW), 1966, p. 80. Considering only the disciplines included in the Cartter study, the following ranges are obtained:

	Percentage Range of Teaching Faculty Holding the Doctorate
Biological Sciences (including Psychology)	98.3 to 71.8
Social Sciences	81.3 to 65.6
Physical Sciences (including Mathematics)	79.8 to 47.9
Engineering	79.3 to 27.3
Humanities	68.7 to 46.7

This range of variation appears potentially to be only partially offset by distinctions between types of institutions (*Ibid.*, p. 60. 59 percent of the teaching faculty in universities held the doctorate, 42 percent in colleges and technological institutions).

On the other hand, the relevance of this factor to quality becomes clear, if single disciplines are examined. For example, the percentage of faculty holding the doctorate in mathematics departments has been related to the increase in the number of engineering doctorates during recent years.

2. One of several possible correlates related to student support, the percentage of graduate students who are self-supporting, at least in the sciences and engineering, does not lead to a factor that relates to quality on the testing procedure used here. Since this is a complex factor that involves the availability of partial or total support for students, the distribution of part-time and full-time students, variations in the amount of support available among disciplines, and student pressure for admission, with or without support, to the institutions of highest quality, further analysis has not been attempted. (See the discussion of baccalaureate-to-doctorate time lapse in Chapter I)
3. An important potential correlate is the amount of physical plant available for graduate education. The number of square feet used for research, the total net usable square feet, or the number of square feet per professional person, both faculty and graduate students, should be examined for correlation with institutional quality. There is, however, insufficient information available at the present time to make a satisfactory analysis.
4. The relationship of library resources to institutional quality has been demonstrated.[7] For this factor to become a fully satisfactory correlate of quality, however, consideration should be given to the character and relevance of the collections, evidence of utilization of the resources, and especially the existence of other accessible libraries in the vicinity of the institution.

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quality classes of the Cartter study. (See *Notices of the American Mathematical Society*, Volume 15, No. 6, October 1968, pp. 869 f.) Considering only Ph.D.-granting institutions:

	1967-1968	1968-1969
"Distinguished" plus "Strong" departments	100%	100%
"Good" plus "Adequate-Plus" departments	96	96
"Other" (at least three Ph.D.'s awarded in previous three years)	79	84
"Other" (two or fewer Ph.D.'s awarded in previous three years)	68	73

The factors assembled in this report have been tested in relation to a scale of quality involving 106 doctoral-granting universities. It cannot be inferred, therefore, that these factors, either by identity or numerical magnitude, are generally applicable to other types of institutions. This reservation is particularly important with respect to the predominantly four-year undergraduate college that has undertaken a limited graduate program at the level of the master's degree. Conversely, however, if an institution commits itself to a doctoral program, it should be appraised under criteria common to doctorate-granting institutions.

MAGNITUDE OF GRADUATE PROGRAM

A generally held *a priori* position would certainly be that the magnitude of a graduate program is independent of its quality, or that a large institution is inherently neither superior nor inferior to a small institution. In fact, the nature of the tutorial relationship between teacher and student that must prevail for a sound graduate experience might even suggest advantages for the latter. On the other hand, graduate education, particularly at the doctoral level, constitutes a distinctive form of education. Values appropriate to elementary, secondary, undergraduate, or even professional education cannot be uncritically interchanged; neither can their relevance to the graduate enterprise be assumed. The experience of the liberal arts college, with or without a master's degree program, cannot reasonably be extrapolated to include the graduate activities of full universities that award the doctorate. The converse is also true. This review is necessarily restricted to the latter class of institutions.

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[7] A. M. Cartter, *op. cit.*, pp. 114-115. If the reported data are translated to accord with the quality classes of this report, the following sequence is obtained:

Quality Class	Range of Library Resources: Index (Median)
A	Greater than 2.00
B	1.00 to 1.49
C	0.75 to 0.99
D	0.50 to 0.74
E	0.50 to 0.74
F	0.50 to 0.74
G	Less than 0.50

There is indeed one circumstance that would be consistent with a positive correlation between magnitude and quality. In general it takes time to build quality. If there are no policy reasons to limit size, then the processes of assembling and improving the faculty, accumulating the resources of libraries and research facilities, developing standards and programs, and establishing a reputation for excellence among potential students and supporters of the institution can occupy decades. At the same time, these processes will progressively generate pressures for expansion. That this type of evolution has in fact occurred can be demonstrated. The time that has elapsed for the development of the graduate program, however, has not been included in this review as a correlate of quality, even though a relationship appears to exist,[8] because its implications with respect to institutional age are neither constructive nor inevitable. At the same time, for planning purposes, it may be of value to note that an average of 17 years of developmental time separates successive median institutions of the first four quality classes, comprising 70 percent of the universities in the sample under review.

DOCTORAL AWARDS

The overall doctoral program of a university is measured most directly by the total number of awards of doctorates in all disciplines. This measure serves to integrate the participation of part-time and full-time students and faculty, long and

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[8] The median time of development of graduate programs has been computed from data listed in *American Universities and Colleges*, Ninth Edition, Washington, American Council on Educaton, 1964, pp. 1263-1265.

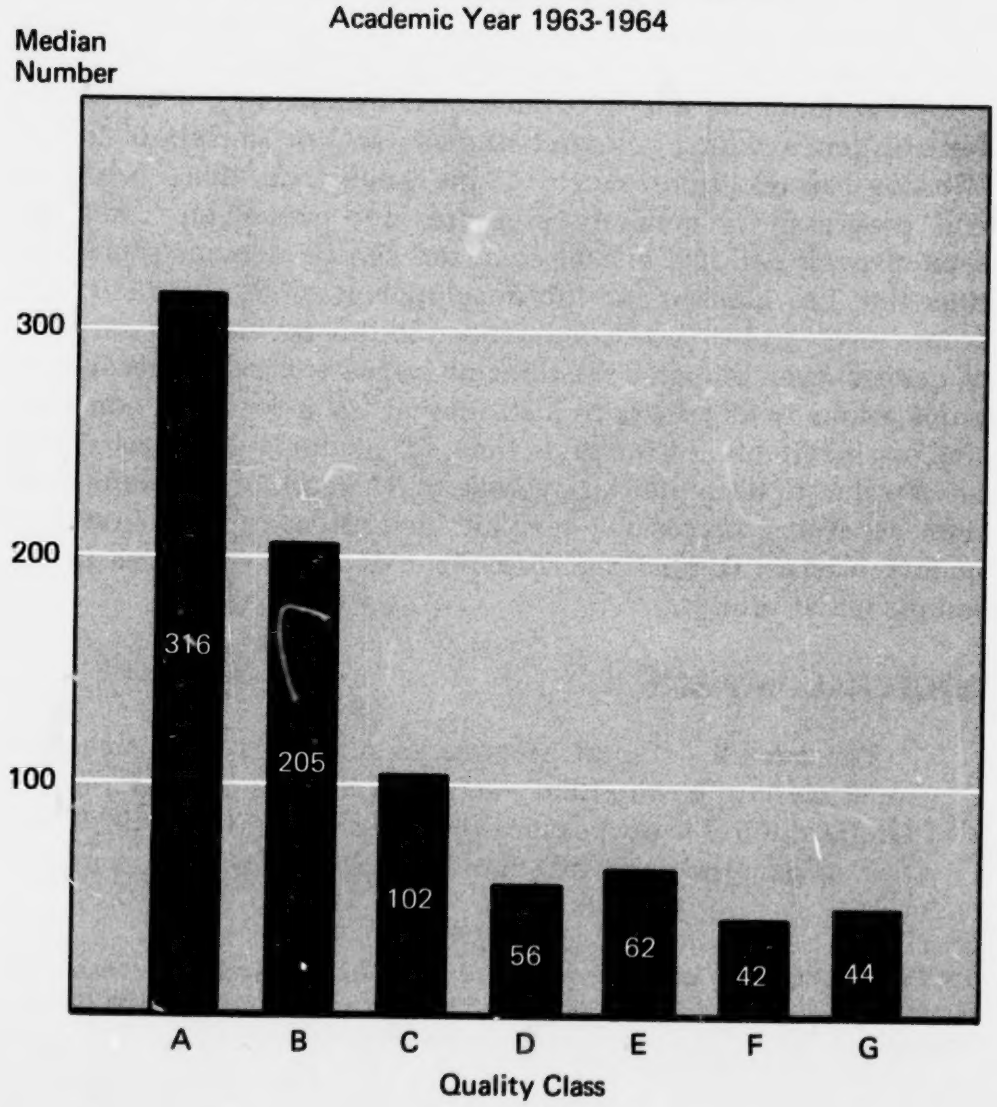
Quality Class	Years of Development Since Award of First Doctorate (Median)
A	82
B	66
C	45
D	30
E	57
F	35
G	30

The anomalous position of Class E, also noted elsewhere, will be discussed in a later section.

Figure 2-1

NUMBER OF DOCTORAL AWARDS

Academic Year 1963-1964



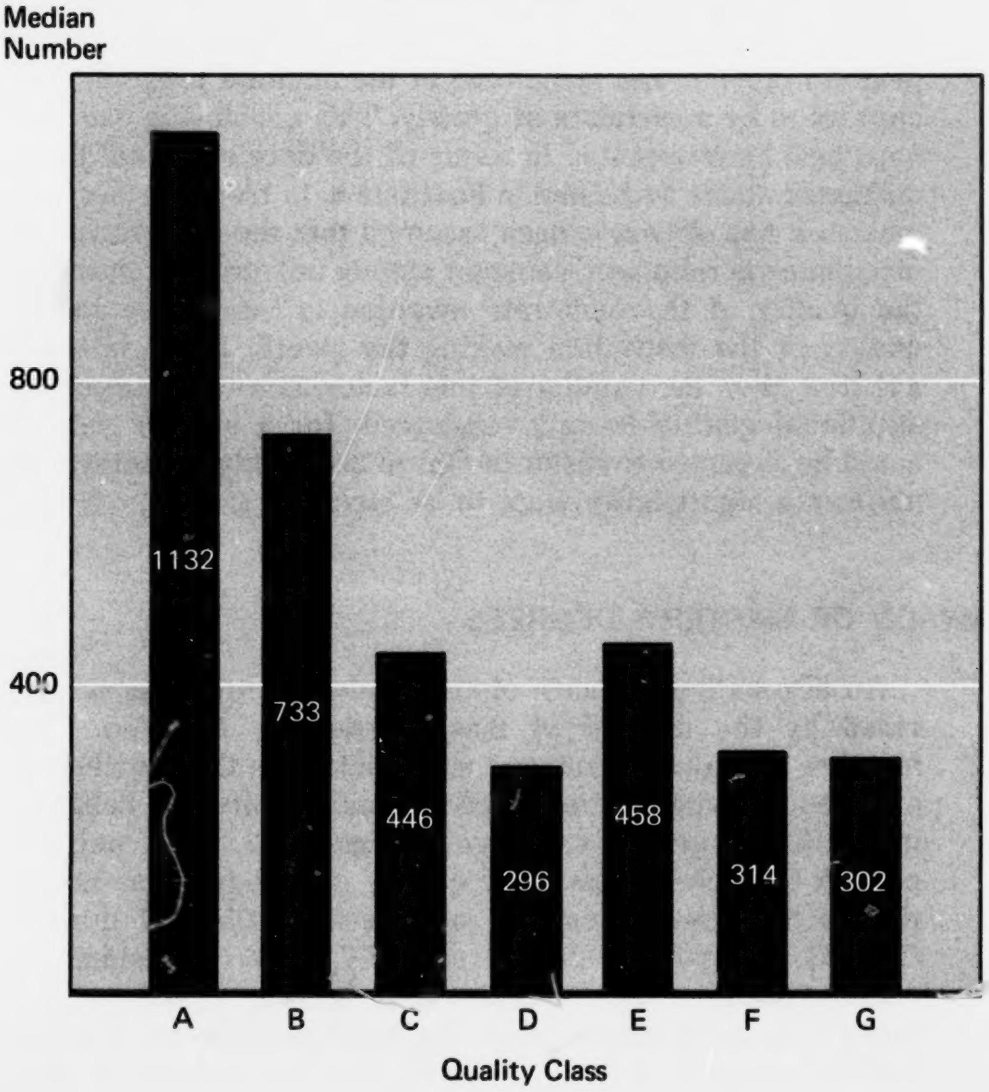
The median number of doctorates awarded by the institutions of each quality class. All disciplines are included.

Source: Office of Education (DHEW)

Figure 2-2

NUMBER OF AWARDS OF MASTER'S DEGREES

Academic Year 1963-1964



The median number of master's degrees awarded by the institutions of each quality class. All disciplines are included.

Source: Office of Education (DHEW)

short times elapsed since the baccalaureate, the availability of financial support for graduate students, and other factors which can influence the total number of degrees awarded in a single academic year. That this number also relates to quality is suggested in Figure 2-1.[9] Apart from Class E and, to a lesser extent, Class G a uniformly decreasing pattern appears to prevail. **The magnitude of the doctoral program thus appears to be a correlate of quality.** This conclusion can perhaps best be interpreted in terms of the developmental times discussed above and listed in Footnote 8. In reaching this conclusion it has of course been assumed that the distribution of disciplines is relatively constant among universities, and that the quality of the doctorate awarded is insensitive to the quality of the institution making the award. If the latter is not true, then the validity of this factor as a correlate of institutional quality is only reinforced, for a steeper pattern could be expected to result in Figure 2-1 if only doctorates of uniformly high quality were to be included.

AWARD OF MASTER'S DEGREES

An alternative measure of the graduate enterprise is provided by the number of master's degrees awarded. This measure too takes account of such factors as the distribution of part-time and full-time students and faculty. Its behavior in relation to quality is shown in Figure 2-2.[10] The uniform pattern through the first four quality classes is clear; nevertheless there is no apparent pattern from Class C through Class G. In particular the position of Class E is considerably more anomalous than was the case for the award of doctorates. **It is concluded that the total number of master's degrees awarded is less successful than the number of doctorates as a correlate of quality.** The significance of the distinction between the two degrees is emphasized if one considers the developmental time that has been experienced by the graduate program of the institution.[11] Although the ratio of number of degrees awarded, especially doctorates, to developmental time appears also to be a correlate of quality, while the anomalous behavior of Class E largely disappears, it should be noted that, apart from Class A, the number of master's degrees awarded bears a nearly linear relationship to the age of the graduate enterprise of the institution. This result appears to support the conclusion that the total number of doctorates awarded does indeed constitute a valid correlate of quality, since it represents more than a simple magnitude achieved after years of growth. It will be noted below that this increment also corresponds to a positive commitment of the institution to graduate education, in relation to the undergraduate division, a commitment which again is clearer for the doctoral than for the master's degree program.

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[9] *Earned Degrees Conferred 1963-1964, Bachelor's and Higher Degrees,* Publication No. OE-54013-64, Washington, Office of Education (DHEW), 1966. This year was chosen to coincide with the date of the Cartter report data.

[10] *Ibid.*

INSTITUTIONAL FUNDING

A second group of factors, which at first glance appear to relate primarily to magnitude and thus only indirectly to quality, is concerned with the amount of funds received by the institution. That these factors may, however, also have quality significance is suggested by the fact that this funding must be periodically renewed. Even for privately controlled universities endowment earnings constitute only a small fraction of total current-fund income.[12] Hence the funding patterns of the institution reflect

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[11] If the developmental time in years (Y) of the graduate program (See Footnote 8) is considered in relation to the annual number of degrees awarded, the following patterns result (ratios of medians):

Quality Class	PhD/Y	MS(or MA)/Y
A	3.9	13.8
B	3.1	11.1
C	2.3	9.9
D	1.9	9.9
E	1.1	8.0
F	1.2	9.0
G	1.5	10.0

[12] From information made available by the Office of Education (DHEW) for academic year 1963-1964, endowment earnings for 58 private universities were 7.6 percent of current-fund income for educational and general purposes.

the combined responses of its various publics to the institution and its needs, and thus presumably to its quality. Two examples will serve to illustrate the character of this type of factor.

FEDERAL RESEARCH FUNDING

There are two reasons why the total amount of Federal research project grants received by a university is especially relevant to this report. In the absence of a cost accounting system (See Chapter III) such research funding becomes one of the few types of accounts that can be almost entirely associated, as a restricted fund, with the graduate educational endeavors of the institution. It is thus a measure of this activity, even though it is not balanced with respect to the distribution of disciplines, being almost wholly directed to the sciences and engineering. The second reason is found in the method used to allocate research support. Every effort has been made by agencies of the Federal Government to support projects of merit, as determined by the judgments of the peers of the investigators. Each award of a research project grant, therefore, represents to this extent an evaluation of the quality of a small element of the graduate program of the institution. The totality of such grants should thus be a correlate of the quality of the total graduate program, and hence comparable with the results of the Cartter study. That this is in fact the case is seen in Figure 2-3. With the exception only of Class F,[13] there is a uniformly decreasing pattern.

NON-FEDERAL FUNDING

In principle, a similar measure is provided by non-Federal current-fund income for educational and general purposes. This income is derived from a wide diversity of sources, each of which must first form a judgment. It is, however, used for a wide diversity of purposes, in addition to graduate education. To the extent that the donors' judgments involve quality, however indirectly, the amount of such funding becomes a potential correlate of **total** institutional quality, one which need not necessarily correlate with the quality classes used as a scale for testing in this report, since the latter relate only to graduate education. Nevertheless, as for Federal research funding, a uniformly decreasing pattern is found, again with the sole exception of Class F, as shown in Figure 2-4. The implication is clear, namely, that **the quality of one major part of an institution is shared by the entire institution. Both Federal research funding and total non-Federal funding are thus correlates of graduate educational quality.** There is, however, a difference and it will be noted that the ratio of the median of Class A to that of Class G is 25.1 for Federal funding and only 5.6 for non-Federal. This fact suggests that, in large measure, the latter may simply have followed the growth of the institution (See Footnote 11), much as the number of awards of master's degrees has done.[14] The total amount of funding, Federal and non-Federal combined, is of course directly related to the magnitude of the university, and hence to its growth, while the non-Federal portion well exceeds the former in total amount. Even the universities of poorest quality, with little or no Federal research funding, are nevertheless institutions in being and are receiving support. The pattern of Footnote 14 is thus not surprising. However, as in the case of total number of doctoral awards, Federal research funding appears to be the more successful correlate of quality, since it represents considerably more than a magnitude achieved after years of continued growth.

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[13] In fact, through the first five quality classes there is a linear relationship between the **logarithm** of Federal research funding and quality.

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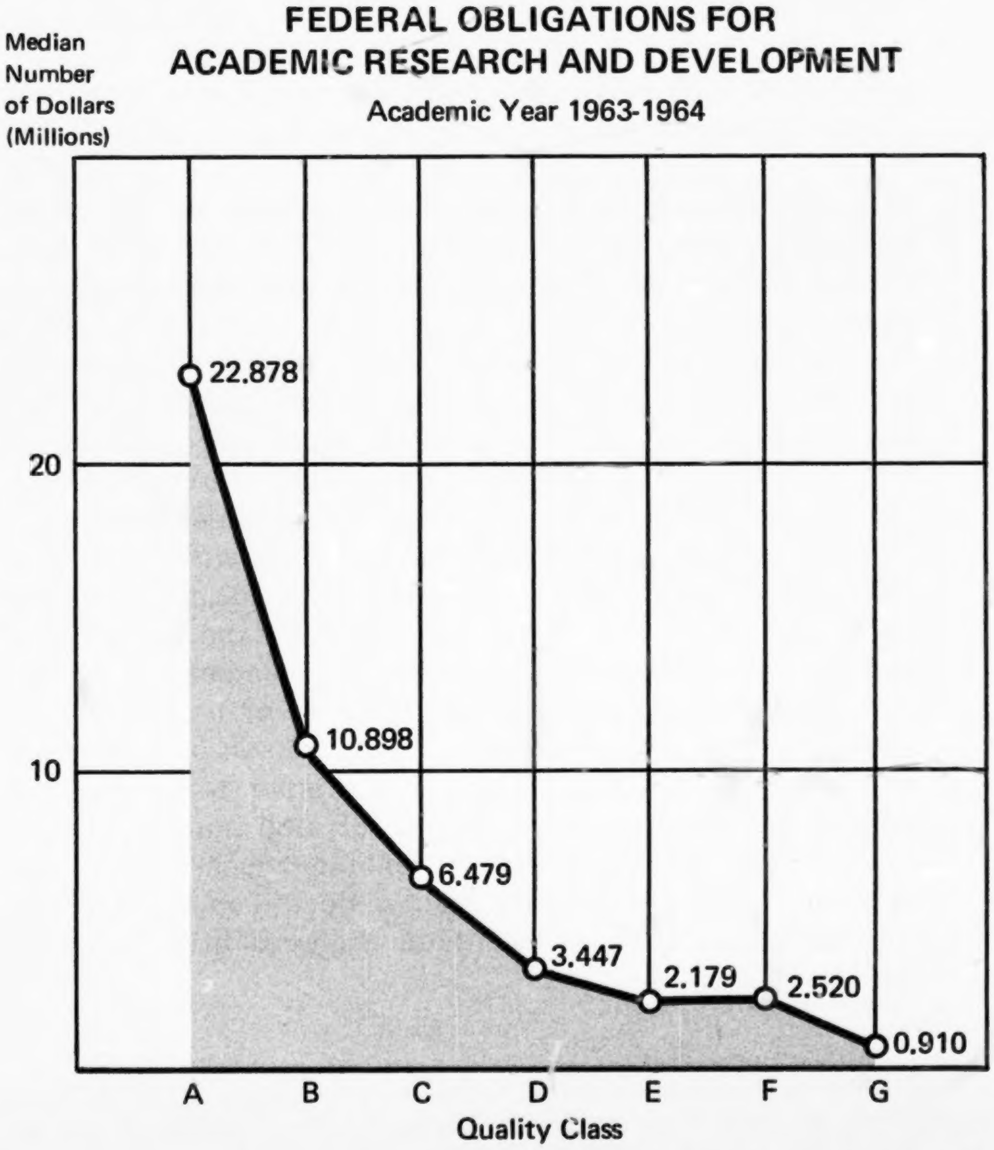
[14] Although not strictly applicable to the total institution, if the developmental time in years (Y) of the graduate program (See Footnotes 8 and 11) is considered in relation to the total amounts of Federal research funding and non-Federal funding, the following patterns result (ratios of medians):

	Dollars (thousands) per year	
Quality Class	Federal/Y	Non-Federal/Y
A	279	698
B	165	557
C	144	565
D	115	530
E	38	249
F	72	543
G	30	341

Figure 2-3

FEDERAL OBLIGATIONS FOR ACADEMIC RESEARCH AND DEVELOPMENT

Academic Year 1963-1964



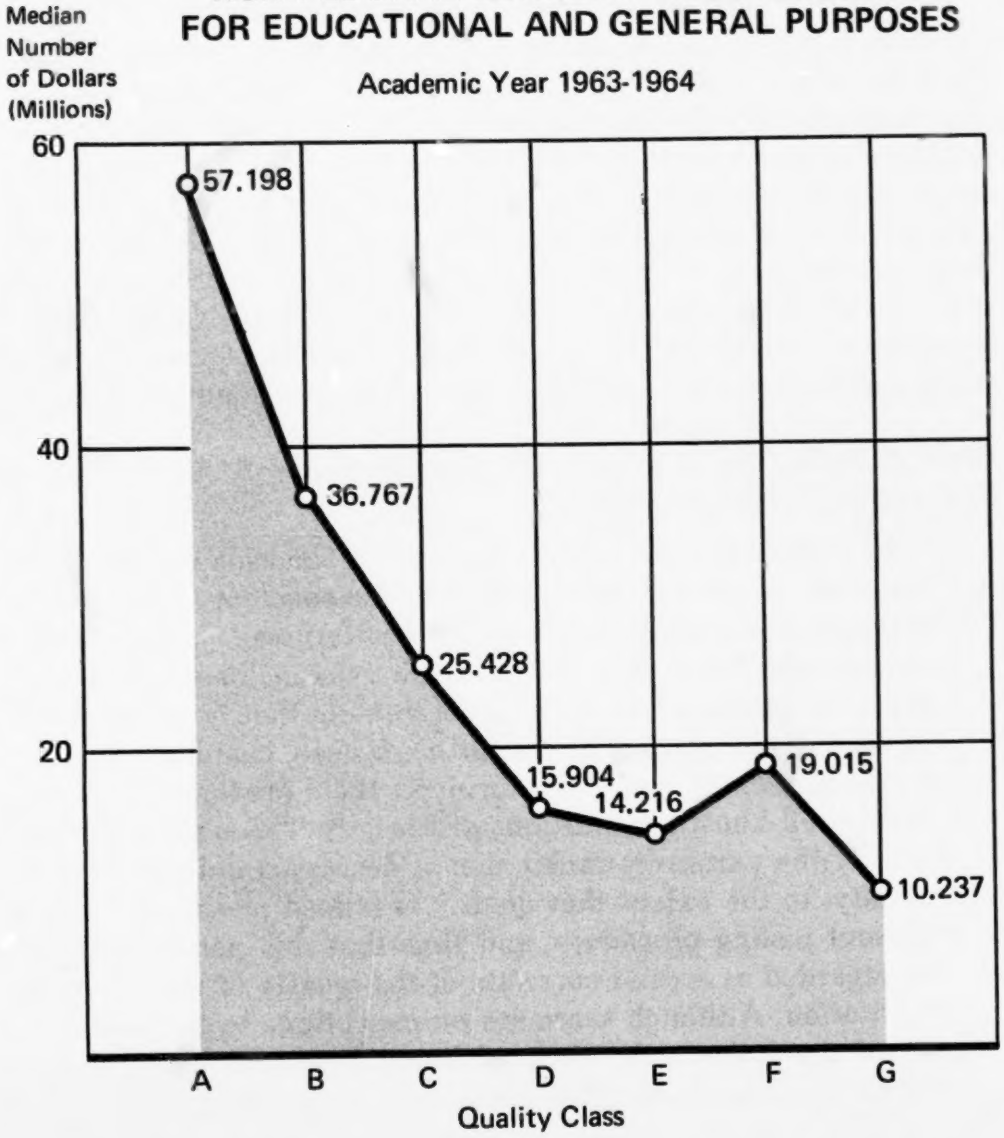
The median value of funds obligated by the Federal Government to the institutions of each quality class for the performance of research and development. The data on which this tabulation is based differ from those reported biennially to the Office of Education (DHEW) by the institutions as current-fund income for educational and general purposes identified with Federal research funding, principally through the inclusion in the latter of support for Federal contract research centers.

Source: ***Federal Support to Universities and Colleges - Fiscal Years 1963-1966,*** **NSF 67-14, Washington, National Science Foundation, 1967, and unpublished data prepared for the Committee on Academic Science and Engineering (Federal Council for Science and Technology).**

Figure 2-4

NON-FEDERAL CURRENT-FUND INCOME FOR EDUCATIONAL AND GENERAL PURPOSES

Academic Year 1963-1964



The median amount of funding received from all non-Federal sources by the institutions of each quality class. This funding includes support for all educational operations of the institution. Excluded is income for auxiliary enterprises and for student scholarships, fellowships, and prizes, as well as income identified with construction of or additions to the physical plant.

Source: Computed from data made available by the Office of Education (DHEW). This data was submitted by individual institutions in reporting for Fiscal Year 1964, the biennial *Financial Statistics of Institutions of Higher Education.*

UNDERGRADUATE SOURCES

As further evidence that graduate educational quality is shared by other parts of the institution, two additional groups of factors are introduced. These factors are concerned with the records of the undergraduate divisions of universities, both as producers of graduate students who subsequently obtain their doctorates and as producers of graduate students judged to be of high quality in national competition.[15] Two types of factors are considered in each case, one denoting a magnitude and one a ratio in order to minimize the effect of size, since it is conceivable that gigantic undergraduate divisions could generate large numbers of graduate students regardless of the qualifications of the average undergraduate.

BACCALAUREATE ORIGINS OF GRADUATE FELLOWSHIP RECIPIENTS

In Figure 2-5 the median number of baccalaureates, who received graduate fellowships in science or engineering through the various programs of the National Science Foundation from fiscal year 1952 through 1964 inclusive, is shown for each quality class. It is not surprising that large numbers of these students, all of whom have been evaluated by national panels, should have received their preparation at the large, well-known institutions of Class A. The significant feature of the pattern is rather that it decreases **uniformly** with quality, to the extent that quality is indeed measured by the present testing procedure, and thus that this parameter may be regarded as a valid correlate of the quality of the graduate institution. Although there are no exceptions to the uniformity of the pattern, the statistical significance of small differences, such as those from Class C to E, is questionable.

This uniformly decreasing characteristic is repeated in Figure 2-6 where the median ratio of numbers of awards to numbers of applicants for graduate fellowships in science and engineering is seen to vary from 36 percent for Class A to less

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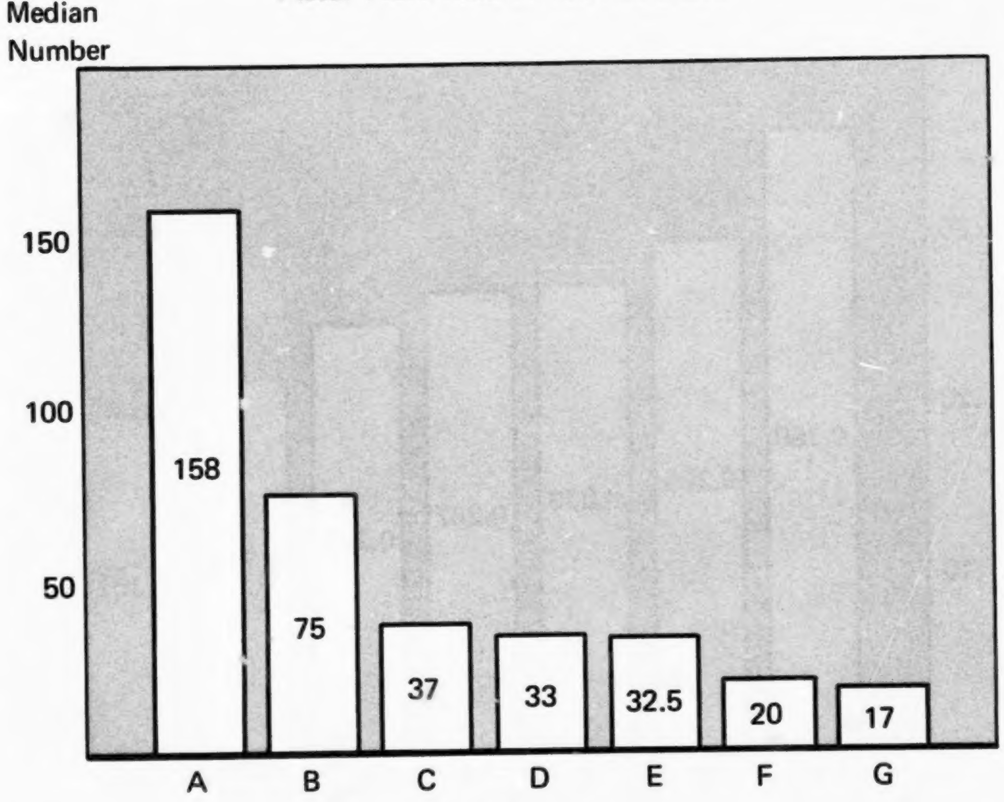
[15] Although outside the scope of this report, it should be noted that the four-year liberal arts colleges, with or without master's degree programs, are quite as successful as the universities with respect to the ratios of Figures 2-6 and 2-8 for comparable numbers of institutions, even though they are considerably smaller in size. (See also Chapter I.)

Figure 2-5

BACCALAUREATE ORIGINS OF RECIPIENTS OF GRADUATE FELLOWSHIP AWARDS

Fiscal Years 1952 to 1964 inclusive



Quality Class

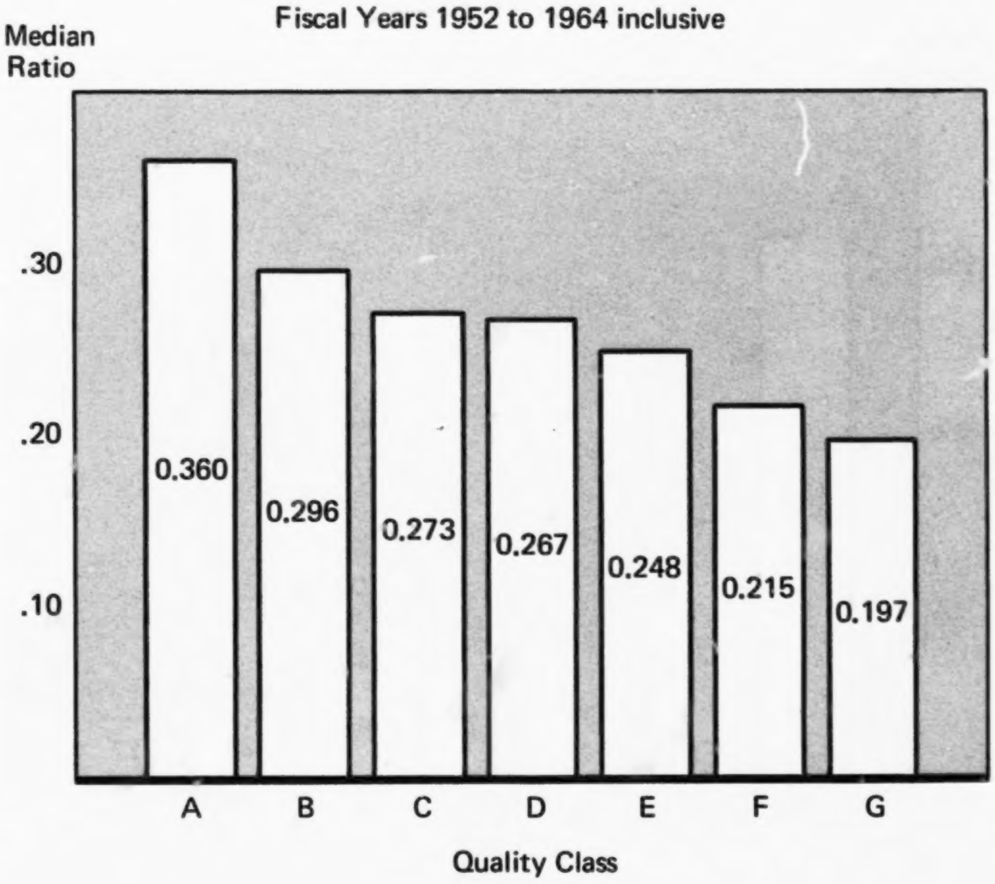
The median number of awards made to students receiving bachelor's degrees in the sciences and engineering during the 13 year period indicated at the institutions of each quality class.

Source: Tabulations of total awards made under the Regular Graduate and Cooperative Graduate Fellowship Programs and the Graduate Summer Fellowship Programs for Teaching Assistants and Secondary School Teachers, Division of Graduate Education in Science, National Science Foundation.

Figure 2-6

RATIO OF TOTAL GRADUATE FELLOWSHIP AWARDS TO TOTAL NUMBER OF APPLICANTS

Fiscal Years 1952 to 1964 inclusive



The median ratio of the total number of awards to the total number of applicants receiving bachelor's degrees in the sciences and engineering during the 13-year period indicated at the institutions of each quality class.

Source: Tabulations of total applications and total awards made under the Regular Graduate and Cooperative Graduate Fellowship Programs and the Graduate Summer Fellowship Programs for Teaching Assistants and Secondary School Teachers, Division of Graduate Education in Science, National Science Foundation.

than 20 percent for Class G. Although entirely uniform, as before, the relatively narrow range of this pattern suggests that larger numbers of undergraduates at the higher quality institutions consider themselves qualified to enter this national competition than at the lower quality institutions; the number of applications would thus exhibit approximately the pattern of Figure 2-5.

BACCALAUREATE ORIGINS OF DOCTORATES

Two additional factors lend further support to the hypothesis that the undergraduate divisions of universities share in total institutional quality, as measured by the graduate divisions. These factors concern the capacity of the institution to produce recipients of bachelor's degrees who are both qualified and motivated not only to enter graduate school but to continue to the successful completion of work for the doctorate. The first of these factors, shown in Figure 2-7, is the median number of baccalaureates awarded by the institutions of each quality class who subsequently received their doctorates in science or engineering during the five-year period from academic year 1958-1959 through 1962-1963, regardless of the identity of the doctoral granting institution. This factor too declines uniformly with quality, with the single exception again of Class E.[16]

The second of these factors, illustrated in Figure 2-8, relates the number of baccalaureates that received doctorates in science and engineering to the total number of baccalaureates. The years chosen are entirely arbitrary, since variations in the time elapsed between baccalaureate and doctorate preclude

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[16] The profiles of Figures 2-7 and 2-8 would be even steeper if these figures referred only to doctorates of more or less uniform quality and if it could be demonstrated that institutions of lower quality tend to produce doctorates of lower quality. One measure of this effect can be found in the percentage of those baccalaureates who subsequently obtained doctorates that indeed received doctorates from Class A institutions. The relevance of this measure is based on the assumptions that (a) students will seek admission to Class A graduate institutions (See Figure 2-10), (b) admission of a graduate student by a Class A institution constitutes an evaluation of the quality of the student, and (c) the quality of the doctorate is measured at

NOTES TO FIGURE 2-7

The median number of doctorates awarded during the years indicated who received their bachelor's degrees at the institutions of each quality class.

Source: National Academy of Science - National Research Council.

NOTES TO FIGURE 2-8

The median ratio for the institutions of each quality class. This ratio is an arbitrary index of the doctoral productivity of the undergraduate divisions of the institutions represented. The ratio compares the number of baccalaureates awarded by the institution who received doctorates during academic years 1958-1959 through 1962-1963 (regardless of the doctoral institution) with the total number of baccalaureates awarded by the institution during academic years 1961-1962 through 1963-1964. Comparable years have not been sought (e.g., through the use of an arbitrary five-year time lag), since the time elapsed between the baccalaureate and the doctorate is not well defined.

Source: National Academy of Sciences - National Research Council for baccalaureate origins of doctorates; Office of Education (DHEW) for total baccalaureate awards.

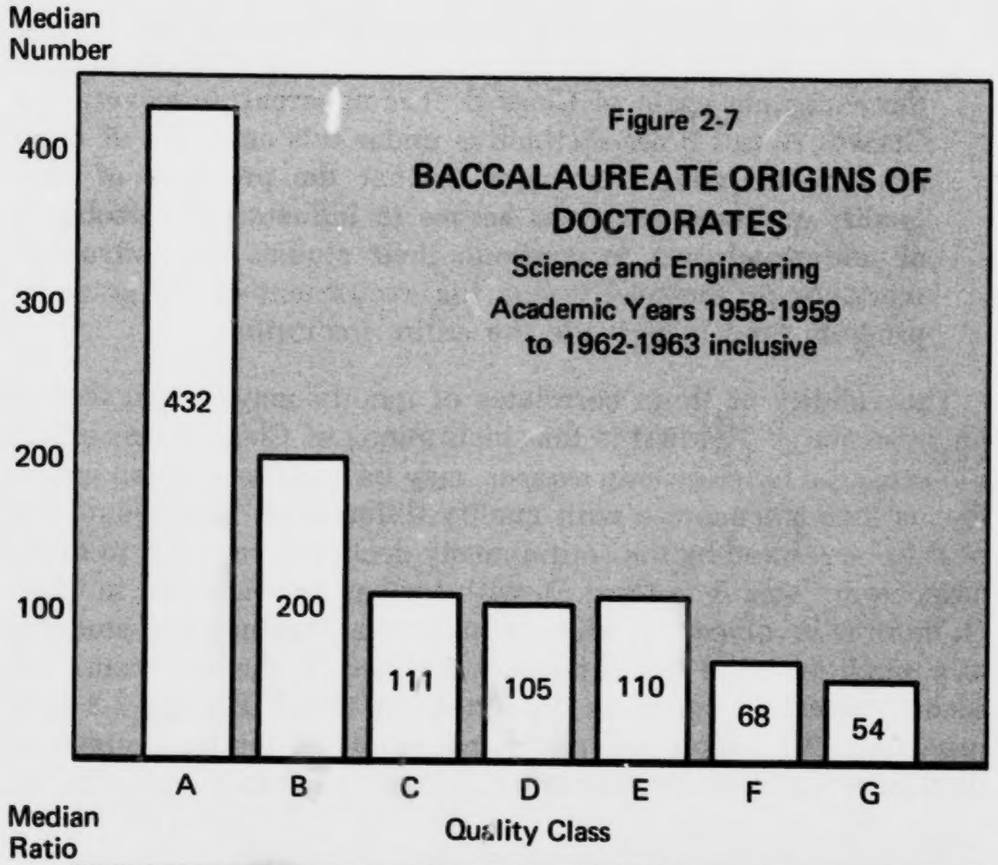

Figure 2-7

BACCALAUREATE ORIGINS OF DOCTORATES

Science and Engineering

Academic Years 1958-1959 to 1962-1963 inclusive

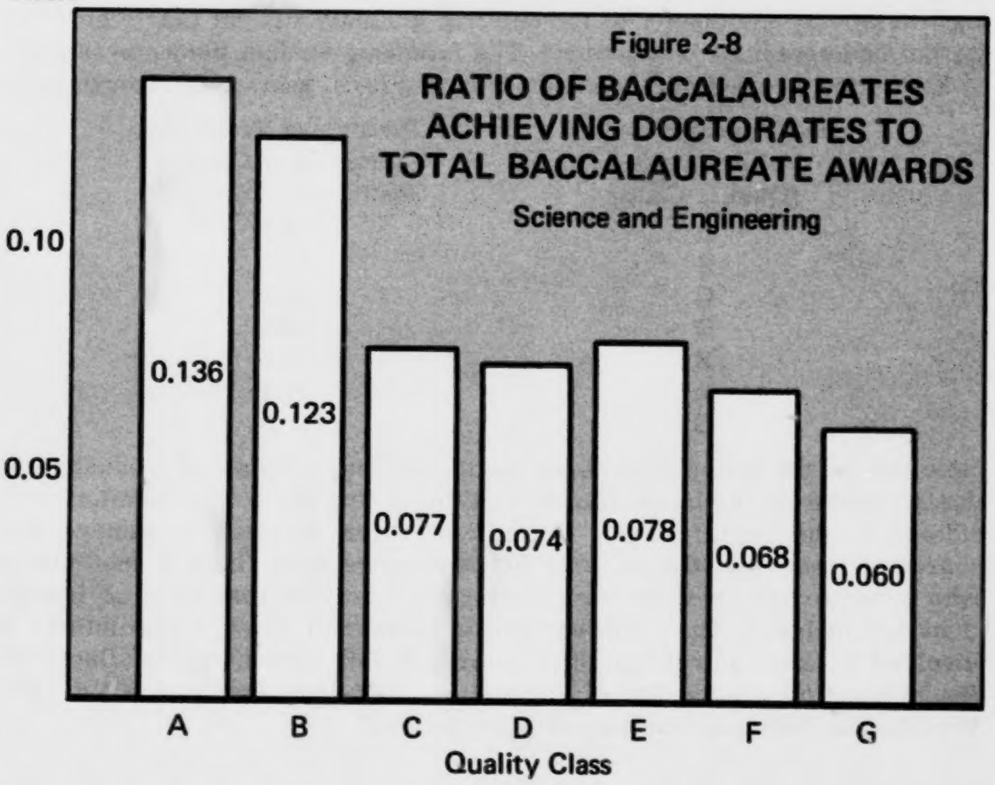

Figure 2-8

RATIO OF BACCALAUREATES ACHIEVING DOCTORATES TO TOTAL BACCALAUREATE AWARDS

Science and Engineering

a satisfactory identification of corresponding years for the two degrees. The ratio declines uniformly with quality, with the exception again of Class E. It is apparent, however, that Classes A and B are distinctive under this correlate of quality. The tentative conclusion is that **the presence of high quality graduate programs serves to influence the decisions of undergraduates to continue their studies into advanced work.** Again the quality and the excitement of the graduate program tend to pervade the entire institution.

The validity of these correlates of quality may be questioned on two counts. The first is that institutions of Class A, especially with regards to fellowship awards, may be successful to an extent that is incommensurate with quality differences. This would appear to be refuted by the continuously declining patterns, **in every case,** from Class A to Class D, with further deterioration to Class G; more is involved, therefore, than special treatment of students at a small group of institutions at one end of the spectrum. The second objection concerns the extent to which Figures 2-5 and, especially, 2-7 simply reflect the magnitude of the undergraduate divisions. To illustrate that more is involved than magnitude, the

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least in part by the quality of the entering graduate student (See Figure 2-9 for the undergraduate counterpart). The following median percentages refer to doctorates received in all disciplines during fiscal years 1958 through 1966.

Baccalaureate Origin of Doctorate (Quality Class)	Percentage Receiving Doctorate at Class A Institutions (Median)
A	27.3
B	27.1
C	22.4
D	23.2
E	21.7
F	17.1
G	17.6

Note that in the majority of cases the largest single group of graduate students remains at the baccalaureate institution (for the 106 universities considered in this report); these figures have been adjusted to remove this source of inequality, that is, only baccalaureates from Class A institutions who subsequently received their doctorates from **different** Class A institutions are included. The same equivalent number of Class A institutions is involved in each percentage. The source of this informaton is: *Doctorate Recipients from United States Universities, 1958-1966,* Publication No. 1489, Washington, National Academy of Sciences, 1967.

ratios of the median value for Class A to that for Class G in Figures 2-5 and 2-7 may be compared with the corresponding ratio for the median number of total baccalaureate awards. Computing the last for academic years 1962-63 to 1964-65, inclusive, the following is obtained. (Note that the median number of baccalaureates is also a correlate of institutional quality):

	Class A to Class G Ratio
Baccalaureates	3.4
Figure 2-5	9.3
Figure 2-7	8.0

The corresponding ratio for Figure 2-8 is 2.3; the product of this value and 3.4 (baccalaureates) is 7.8, a value that approximates the value of 8.0 for Figure 2-7. A tentative conclusion is that Figure 2-7 represents both a magnitude (number of baccalaureates) and an additional factor with quality import (ratio of baccalaureate origins to baccalaureates).

PUBLIC RESPONSE

Several of the factors discussed above, notably those involving funding, concerned measures of the public reaction to the institution. Three additional factors are introduced to illustrate the response of an important segment of the public, that is, the students themselves. Considered together, these three factors bracket the institution and serve to confirm further the thesis that quality is an attribute of the total institution.[17]

FRESHMAN ADMISSIONS SELECTIVITY

In Figure 2-9 is illustrated a measure of the quality of the freshman class. Since it has been computed from two factors,

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[17] The fact that high quality students tend to assemble at high quality institutions does not in any way detract from the importance of the quality of the institution. Nor does it imply that these students would achieve the same objectives wherever they went. To the contrary, the resources of the institution, their mutual interactions, and the students themselves are all part of the complex which determines institutional quality. Neither an institution without students nor students without an institution can achieve educational goals. Similarly, a high quality institution with predominantly poor students, or excellent students at a generally low quality institution, becomes a contradiction in terms.

NOTES TO FIGURE 2-9

The median for the institutions of each quality class of an index designed to measure both the choice of an institution by prospective freshmen of high ability and the response of the institution. The index represents the number of semifinalists and recipients of the Letter of Commendation from the 1961 National Merit Scholarship program who named the institution as either first or second choice, divided by the number of freshmen admitted to the institution that year. This ratio is expressed as a "T-score": The mean is 50; about two-thirds of the institutions lie between 40 and 60; about 95 percent lie between 30 and 70.

Source: Alexander W. Astin, *Who Goes Where to College?,* Chicago, Science Research Associates, Inc. 1965.

NOTES TO FIGURE 2-10

The median number of students receiving fellowships in Fiscal Years 1963 through 1967 under the Graduate Fellowship Program of the National Science Foundation that chose the institutions of each quality class for graduate work.

Source: Division of Graduate Education in Science, National Science Foundation

NOTES TO FIGURE 2-11

The median number of postdoctoral students in science and engineering in the Fall of 1966 at the institutions of each quality class.

Source: Departmental data submitted by institutions in application to the Graduate Traineeship Program, Division of Graduate Education in Science, National Science Foundation. A general analysis of this data is contained in *Graduate Student Support and Manpower Resources in Graduate Science Education, Fall 1965-Fall 1966,* NSF 68-13, Washington, National Science Foundation, 1968.

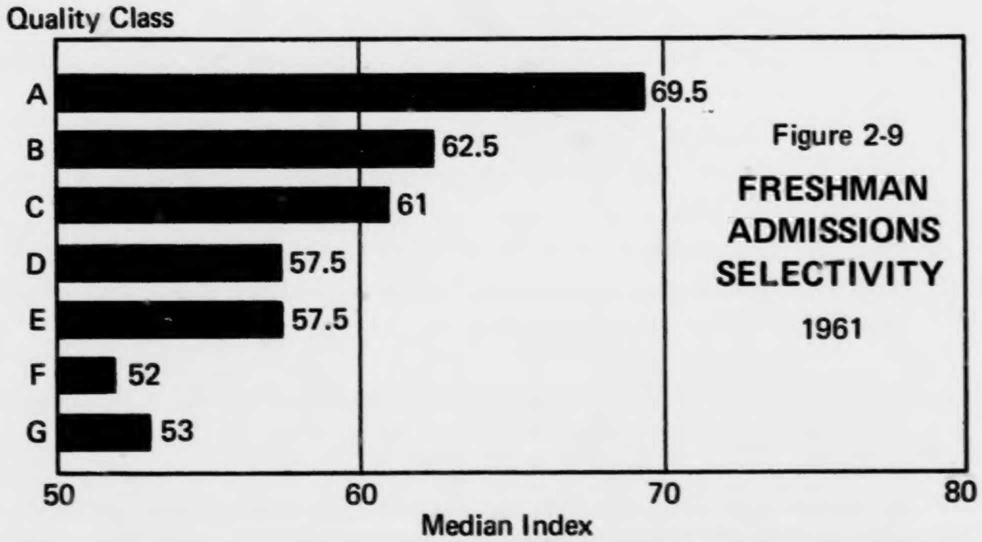

Figure 2-9

FRESHMAN ADMISSIONS SELECTIVITY

1961

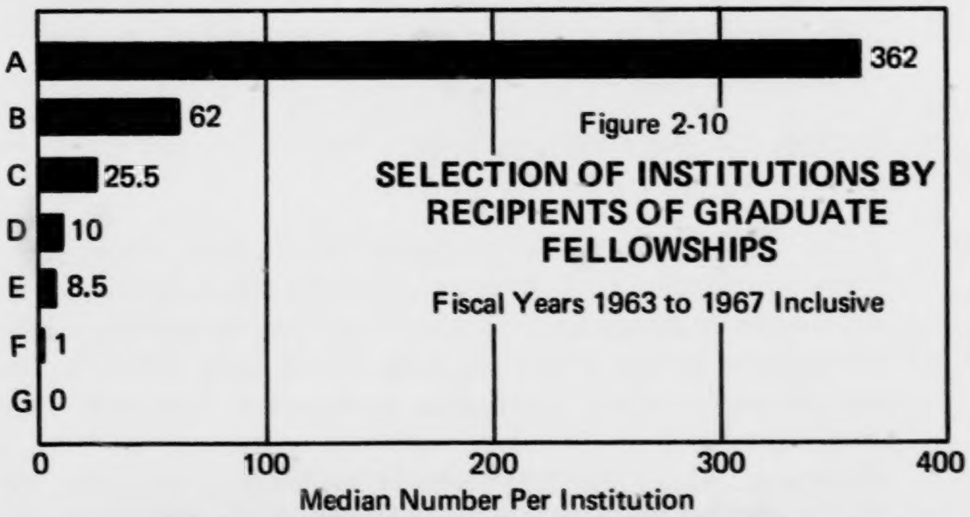

Figure 2-10

SELECTION OF INSTITUTIONS BY RECIPIENTS OF GRADUATE FELLOWSHIPS

Fiscal Years 1963 to 1967 Inclusive

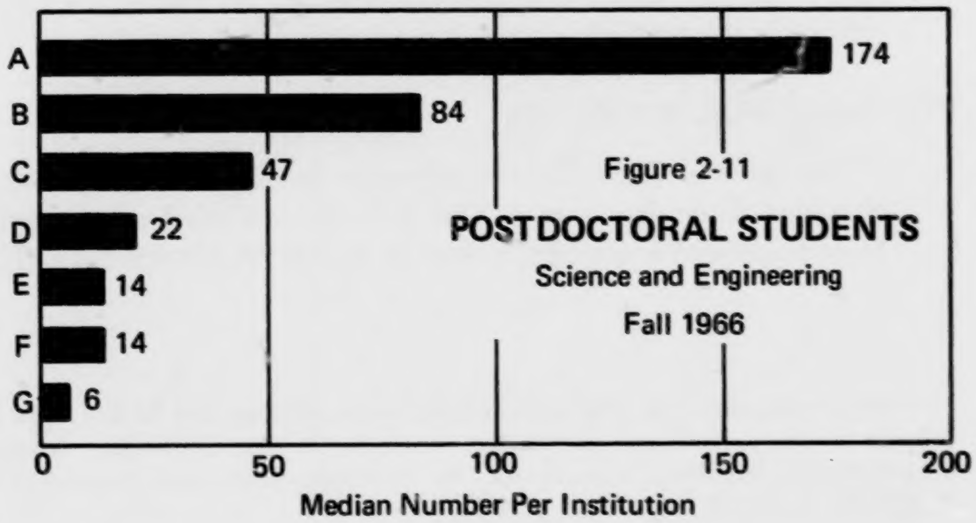

Figure 2-11

POSTDOCTORAL STUDENTS

Science and Engineering

Fall 1966

the selection of institutions by those who have done well in the National Merit Scholarship program and the response of the institution in forming its freshman class, this measure can be regarded alternatively as an indicator of student evaluation of the institution or of admission standards of the institution. The former appears to be primary, however, for the institution could not rank high on this factor and at the same time maintain a student body of stable size, unless the students chose to attend the institution.

Two features of the distribution may be noted: it decreases uniformly with quality, with the exception of Class G and to a lesser extent Class E (equal to Class D); no quality class is below the average (Index = 50) for institutions of higher education in the United States. The freshman class thus conforms generally to a quality scale established on the basis of the graduate program.

SELECTION OF INSTITUTIONS BY GRADUATE FELLOWSHIP RECIPIENTS

The second of these measures of student evaluation is shown in Figure 2-10. Recipients of graduate fellowships in science or engineering from the National Science Foundation during the five-year period from fiscal year 1963 to 1967, awards made on the basis of an evaluation of student merit, chose graduate institutions with the resultant distribution illustrated. The pattern is entirely uniform. It may be noted that a similar distribution is obtained if recipients of other types of national fellowships are included.[18]

POSTDOCTORAL STUDENTS

The third of these factors refers to those who have already obtained their doctorates. The information used relates only to science and engineering and is shown in Figure 2-11. The pattern is similar to that in Figure 2-10. The value for Class E is equal to that for Class F; in Figure 2-10 it is closer to Class D than to Class F.[19]

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[18] For information that also includes Woodrow Wilson and NDEA Title IV fellows for the period 1960 to 1963, see Allan M. Cartter, *Qualitative Aspects of Southern University Education*, The Southern Economic Journal, Vol. XXXII, No. 1, Part 2, July 1965, pp. 58 f.

There is thus general consistency in the evaluation of institutions by students of high quality, whether these students be in their senior year of secondary school, in their senior year of college, or at the level of post-doctoral work. To the extent that these evaluations also reflect the attitudes of associates, parents, teachers, and others, the resulting pattern appears to represent the combined quality judgment of a broad sector of the public. A caveat, however, is necessary in this regard, for the postdoctoral selection probably represents the most valid assessment of contemporary faculty and research quality; the others are more likely to be influenced by opinions formed years earlier. Such opinions can lag behind reality with respect to an institution that has improved or declined significantly during the interim.

INSTITUTIONAL OPERATIONS

The remaining factors to be reviewed are specifically addressed to the internal operations and policies of the institution, particularly as they affect graduate education. These factors are, to a large extent, under the control of the institution, in contrast with the various factors, discussed above, which reflect primarily the results or success of operations, including the attitudes of various groups in the environment of the institution.

DOCTORAL AWARDS PER FACULTY MEMBER

In Figure 2-12 is shown the median ratio of the number of doctoral awards in science and engineering to the number of graduate faculty members (See Notes to Figure 2-12 for definition), computed from departmental data submitted by the institutions to the National Science Foundation during the Fall of 1966. That this ratio forms a quality correlate is

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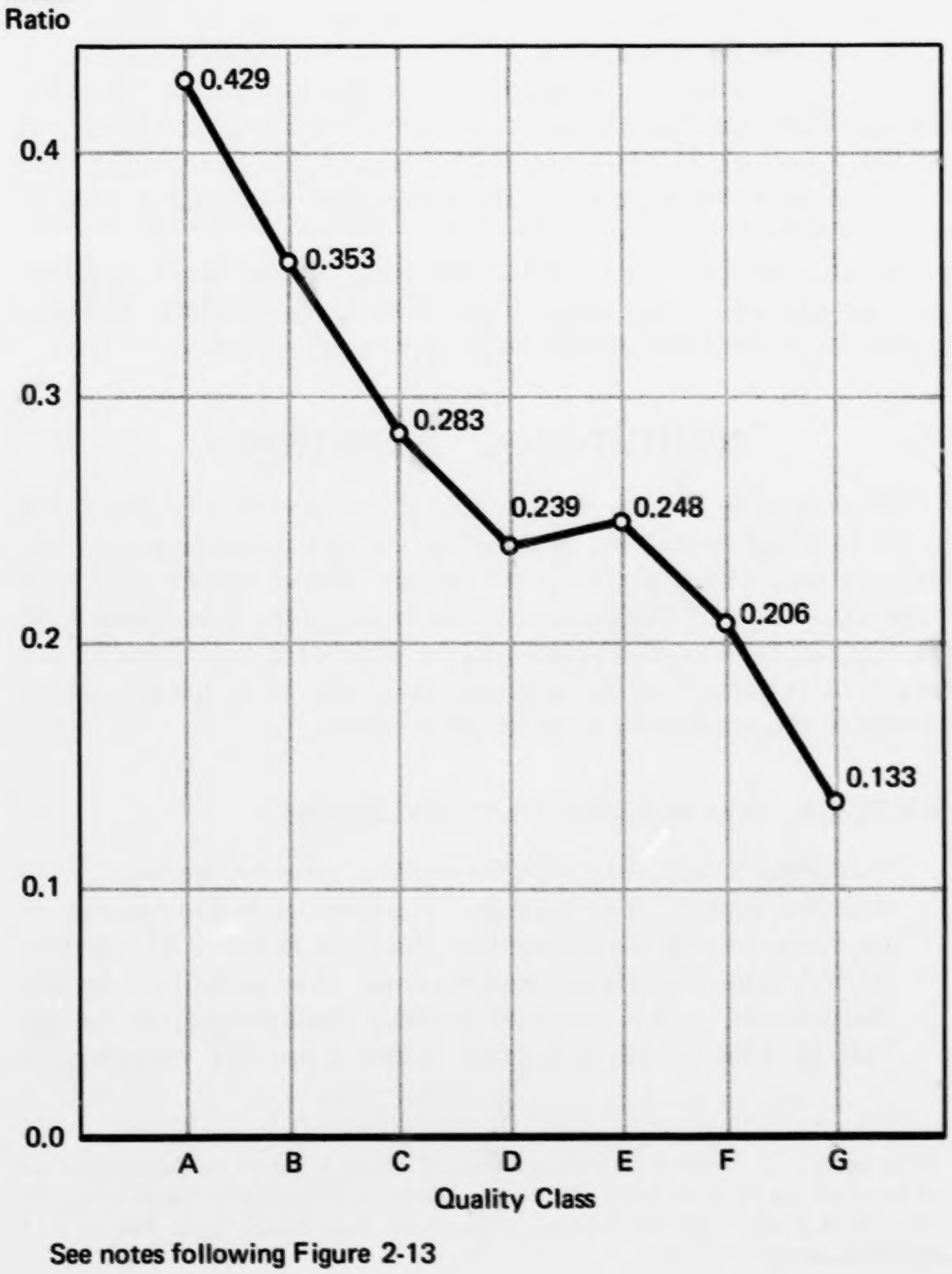
[19] It should be noted that the position of Class E tends to deteriorate as the level of the student group increases. Thus, in Figure 2-9, Class E equals Class D; in Figure 2-10 it is close to but less than Class D; in Figure 2-11 Class E is equal to Class F.

Figure 2-12

DOCTORAL AWARDS PER MEMBER OF GRADUATE FACULTY

Science and Engineering

Fall 1966



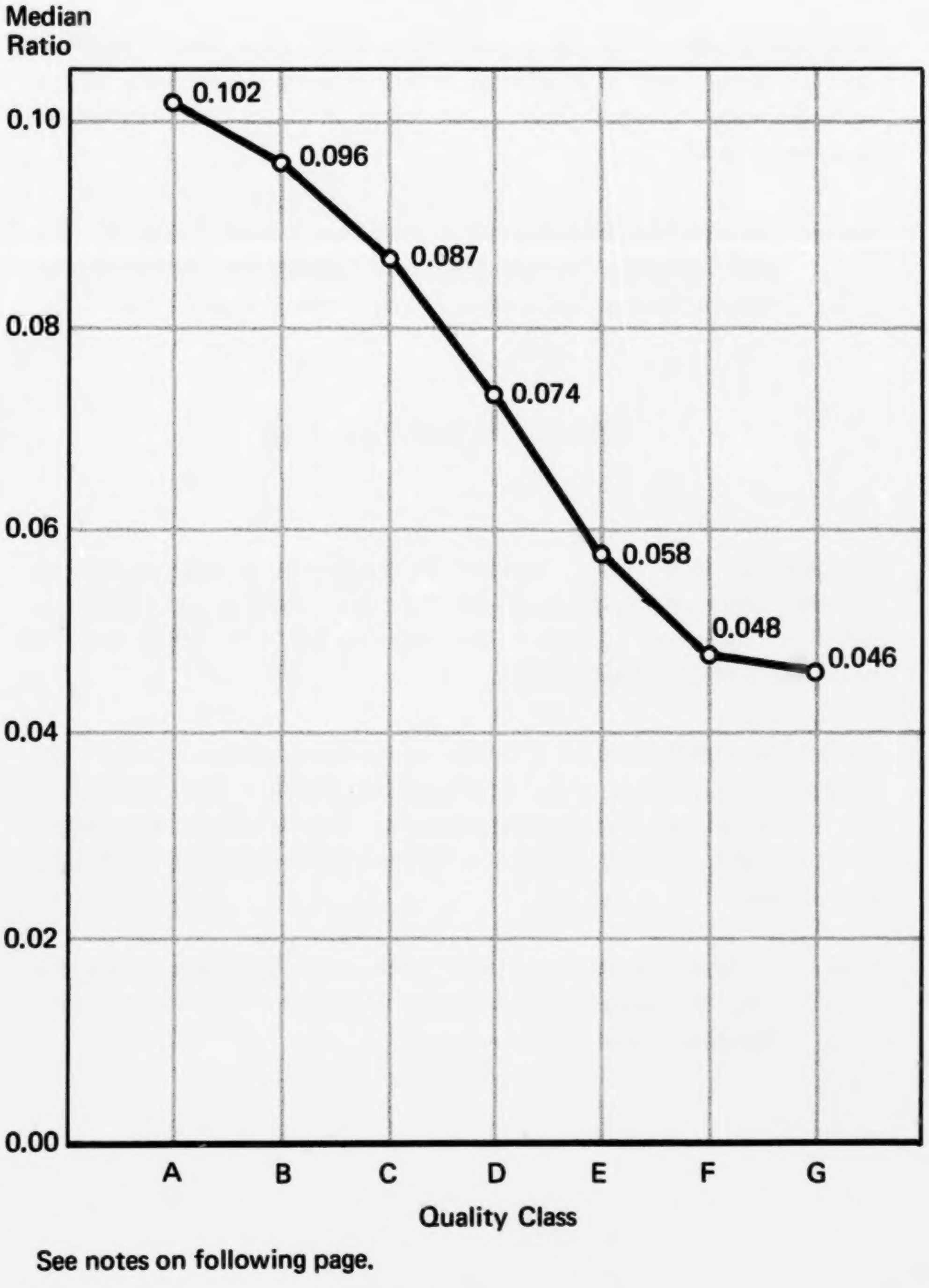
See notes following Figure 2-13

Figure 2-13

DOCTORAL AWARDS PER GRADUATE STUDENT

Science and Engineering

Fall 1966



See notes on following page.

NOTES TO FIGURE 2-12

The median ratio of the number of doctorates in science and engineering awarded during academic year 1965-1966 to the number of graduate faculty members in the Fall 1966 for the institutions of each quality class.

Graduate faculty is defined as consisting of full-time faculty members with academic rank of instructor or higher who are teaching one or more graduate courses or directing the research of one or more graduate students or both.

Source: Departmental data submitted by institutions in application to the Graduate Traineeship Program, Division of Graduate Education in Science, National Science Foundation. See also notes to Figure 2-11.

NOTES TO FIGURE 2-13

The median ratio of the number of doctorates in science and engineering awarded during academic year 1965-1966 to the number of full-time equivalent graduate students in the Fall 1966 for the institutions of each quality class.

An arbitrary definition of full-time equivalent graduate students was adopted: the number of full-time graduate students plus one-third of the number of part-time graduate students. The definitions of full-time and part-time students are subject to the interpretations of individual institutions.

Source: Departmental data submitted by institutions in application to the Graduate Traineeship Program, Division of Graduate Education in Science, National Science Foundation.

demonstrated again by the generally regular pattern, only a slight deviation being caused by the anomalous Class E.

The causes of a relatively high value of this ratio are important. They include (a) a high graduate student-faculty ratio, (b) adequate numbers of graduate students of high quality, (c) graduate faculty members who are effective in stimulating and guiding students, (d) greater emphasis by the institution on doctoral than on master's degree programs, or a combination of these and perhaps additional factors. Alone, this factor cannot be interpreted further. The fact that Class A and Class G differ by a factor of more than 3, however, suggests the importance of seeking an interpretation in each institution.

DOCTORAL AWARDS PER GRADUATE STUDENT

A related measure is provided by the ratio of doctoral awards in science and engineering to the number of full-time equivalent graduate students. The pattern for this factor is shown in Figure 2-13, based again on data from the Fall of 1966.[20] In this case the pattern is completely uniform, thus establishing the ratio as a correlate of quality.

Apart from a high student-faculty ratio, the causes of a relatively high value of this ratio appear to be essentially the same as those for the preceding factor (See Figure 2-12). In addition, the pattern reflects the relatively high master's: doctorate ratios in Classes D to F (See Footnote 22). Since Class A and Class G differ by a factor of slightly more than two, Figures 2-12 and 2-13 together suggest that the student-faculty ratio itself is a correlate of quality, with Class A and Class G differing by a factor of less than two, and that the anomalous behavior of Class E in this instance can be accounted for by a relatively high student-faculty ratio. All three of these inferences are fully supported.[21]

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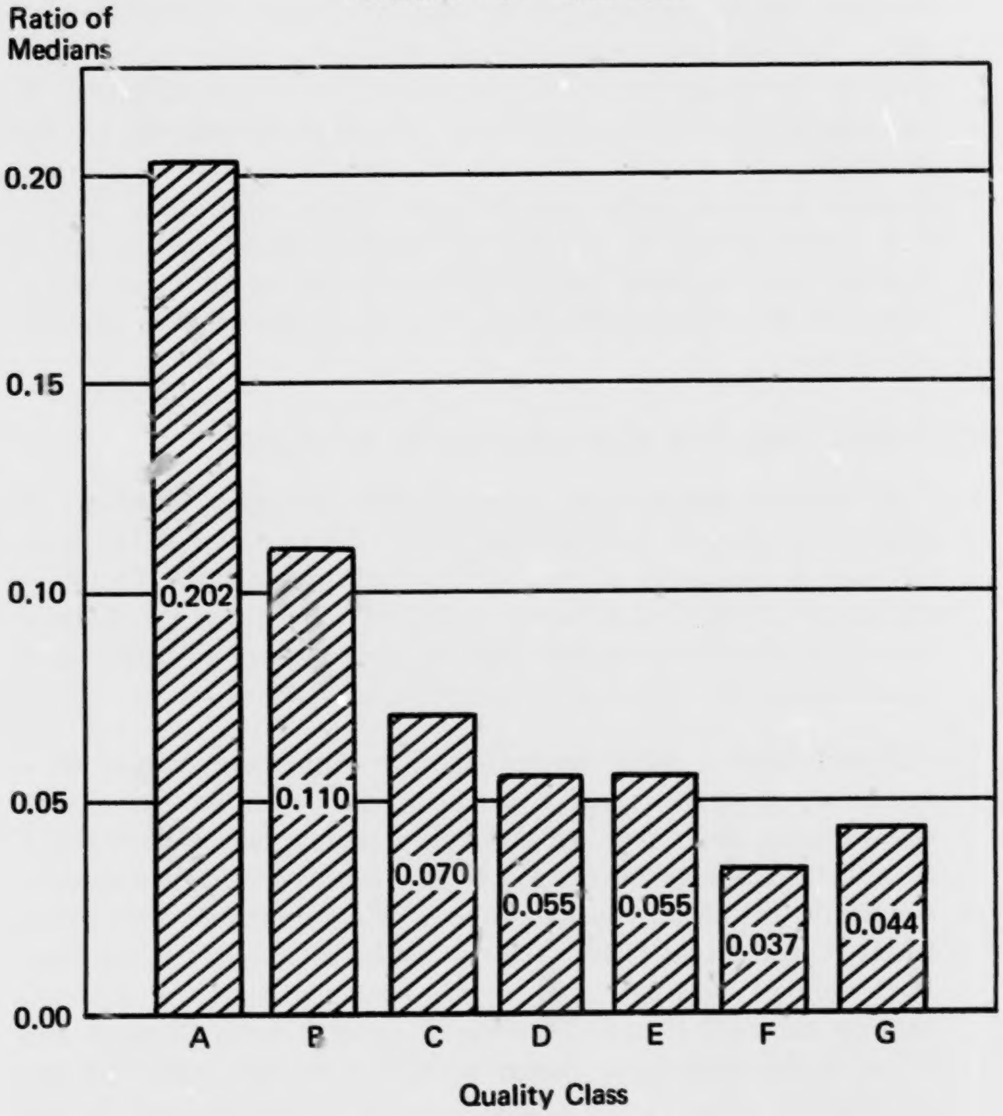
[20] See notes to Figure 2-13 for a definition of full-time equivalent graduate student; this definition is troublesome but cannot be avoided, since the ratio of full-time to part-time students varies widely among institutions.

[21] See Figure 2-18 below where the graduate student-faculty ratio has been computed for only full-time graduate students.

Figure 2-14

RATIO OF DOCTORATES TO BACCALAUREATES

Academic Year 1963-1964



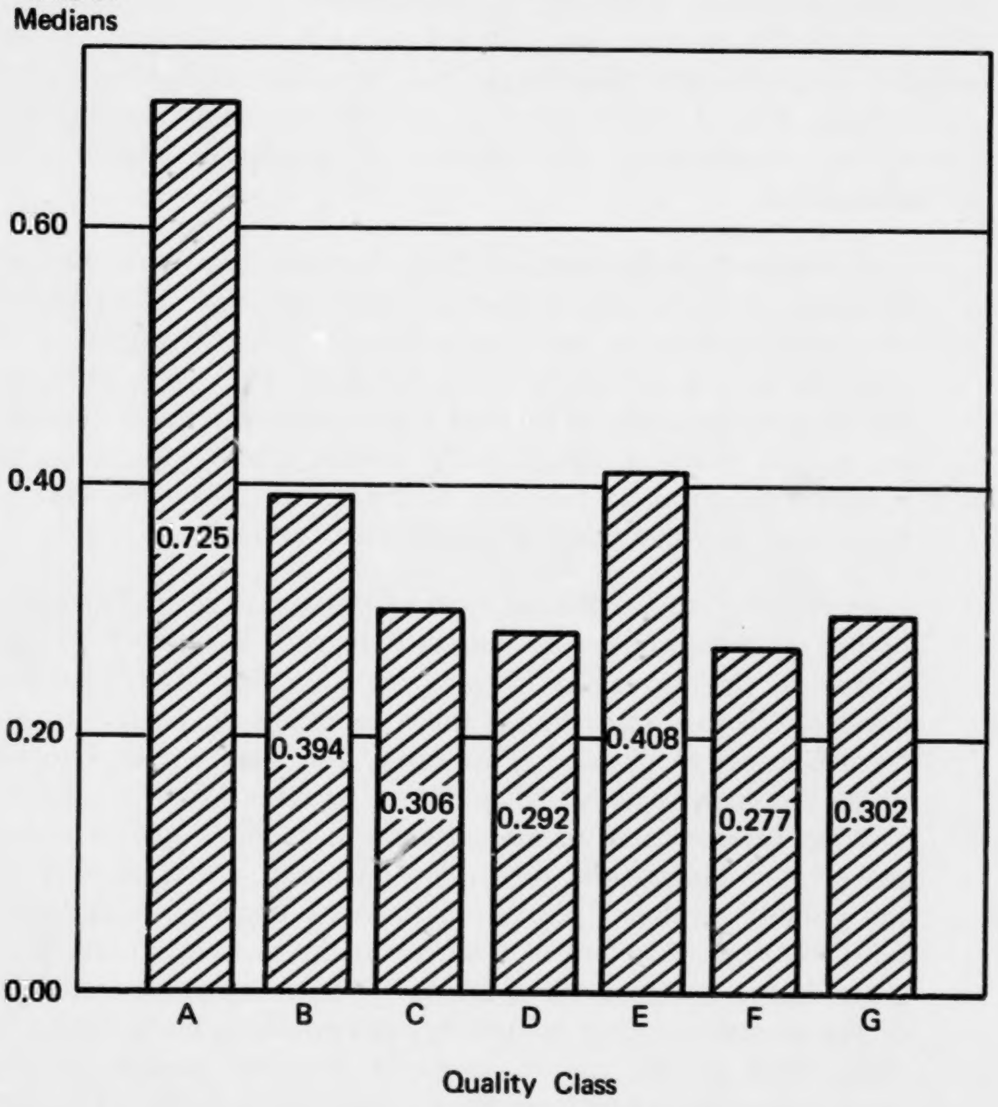
The ratio of the median number of doctorates awarded during academic year 1963-1964 to the median number of bachelor's degrees awarded during the same year for the institutions of each quality class. Institutions that do not offer baccalaureate programs have been omitted from the tabulation.

Source: Office of Education (DHEW). See also Figure 2-1.

Figure 2-15

RATIO OF MASTER'S DEGREES TO BACCALAUREATES

Academic Year 1963-1964



The ratio of the median number of master's degrees awarded during academic year 1963-1964 to the median number of bachelor's degrees awarded during the same year for the institutions of each quality class. Institutions that do not offer baccalaureate programs have been omitted from the tabulation.

Source: Office of Education (DHEW). See also Figure 2-2.

GRADUATE-UNDERGRADUATE RELATIONSHIP

Various of the factors above suggest that high quality graduate institutions may have tended, as a matter of policy, to emphasize graduate education, especially at the doctoral level. For example, the ratio of the median for Class A to that for Class G is far greater for doctorates (See Figure 2-1) than for master's degrees (See Figure 2-2). A direct measure of this emphasis can be obtained by considering the ratios of graduate degrees to baccalaureates.

In Figure 2-14 the ratio of total doctoral awards to baccalaureates is shown for academic year 1963-1964. The pattern decreases uniformly, with the relatively minor exceptions of Class G and, to a lesser extent, Class E. The implication of this pattern appears to be that high quality graduate institutions have made a significantly greater commitment to the doctoral program, in relation to the undergraduate division, than have lower quality graduate institutions.

In Figure 2-15 a different type of pattern is seen. The ratio of the median number of master's degrees to that of baccalaureates decreases uniformly for the first four quality classes. On the other hand, there is really no clear pattern from Class B to Class G. This ratio, therefore, appears to be at best a weak correlate of quality. The situation is similar to that for total awards of master's degrees (See Figure 2-2 and the related discussion above).[22] Especially noted should be the greater emphasis placed on master's degrees, in contrast with the doctorate and in relation to the undergraduate program, by the institutions of Class E. The relative insensitivity of the master's degree to quality, as appraised on the quality scale used in this report, suggests that the quality of the total institution, apart from the professional schools, can most appropriately be considered in terms of the quality of the undergraduate and doctoral programs, rather than in terms of the master's degree program, however important the latter may be to society. Although outside the scope of this report, it may be preferable to treat the master's degree program as an adjunct of the undergraduate program, thus providing a possible source of continuity for an analysis of the liberal arts colleges, especially those that award the master's degree.

INSTITUTIONAL POLICY

Four factors that significantly affect the quality of graduate programs are substantially controlled by the policies of those who support or administer the institution.

FACULTY COMPENSATION

To assemble a faculty of first quality it is necessary to pay the market price. Such faculty is always in short supply. Hence, the compensation of the faculty becomes *a fortiori* a central indicator of the quality of the institution. That this is indeed the case is seen in Figure 2-16 where the compensation for the four characteristic faculty ranks is shown for academic year 1967-1968.

It is clear from the figure that a single institution-wide compensation index or average is less significant, as a correlate of quality, than the compensation of a single faculty rank. The nine-month, total compensation of the full professor is clearly decisive with respect to quality, for the pattern is entirely uniform and the range is large.[23] Compen-

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[22] A better correlate of quality is available in the ratio of master's degrees to doctorates. Considering the medians of Figures 2-1 and 2-2 the following sequence is obtained:

Quality Class	Ratio of Median Number of Master's Degrees to that of Doctorates
A	3.58
B	3.58
C	4.37
D	5.29
E	7.39
F	7.48
G	6.86

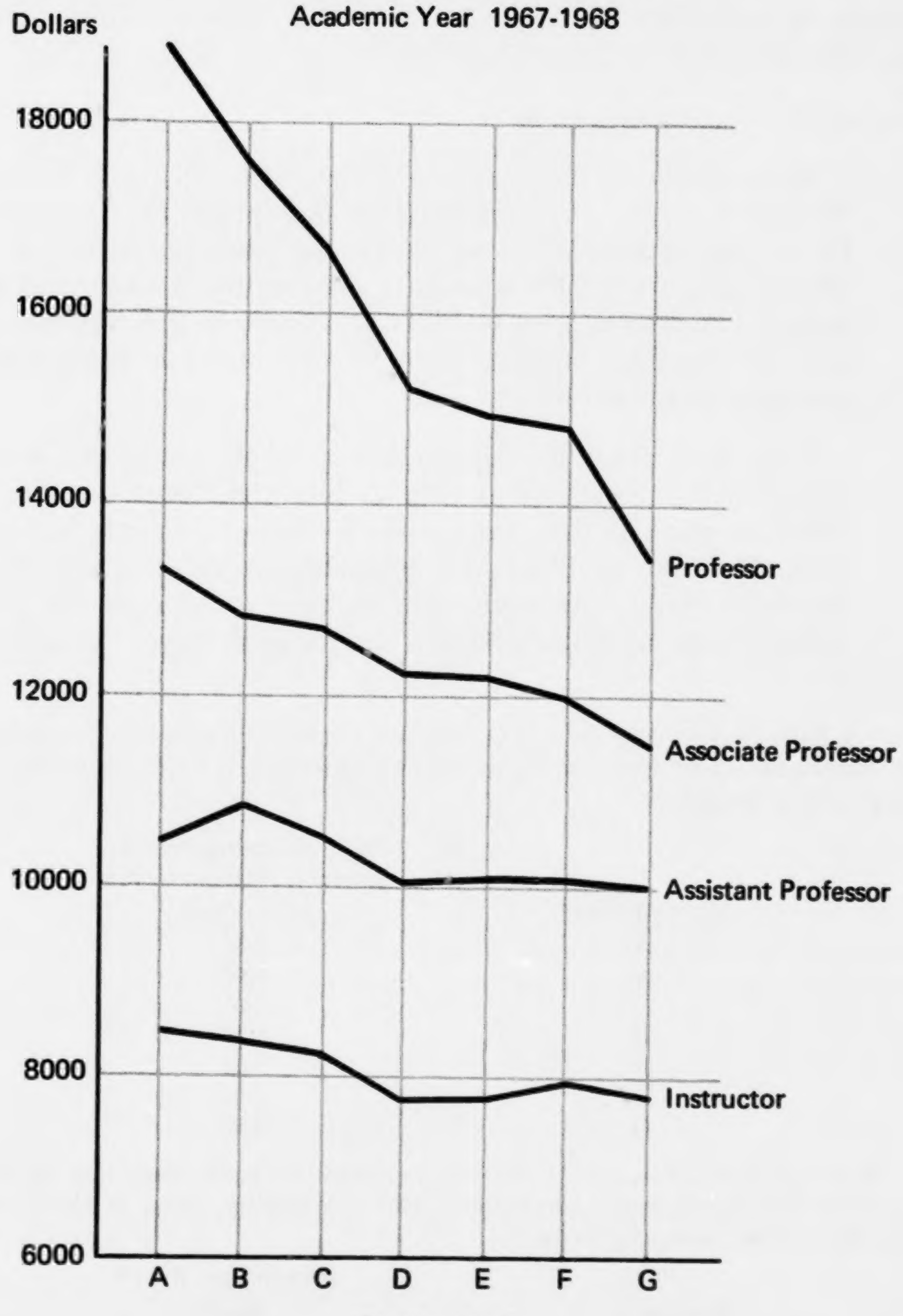
[23] The percentage range of the compensation of each rank, that is, the percent that the highest compensation [for any quality class] is above the lowest, has the following pattern:

Rank	Percentage Range
Professor	40.0%
Associate Professor	15.7
Assistant Professor	9.7
Instructor	10.1

Figure 2-16

FACULTY COMPENSATION

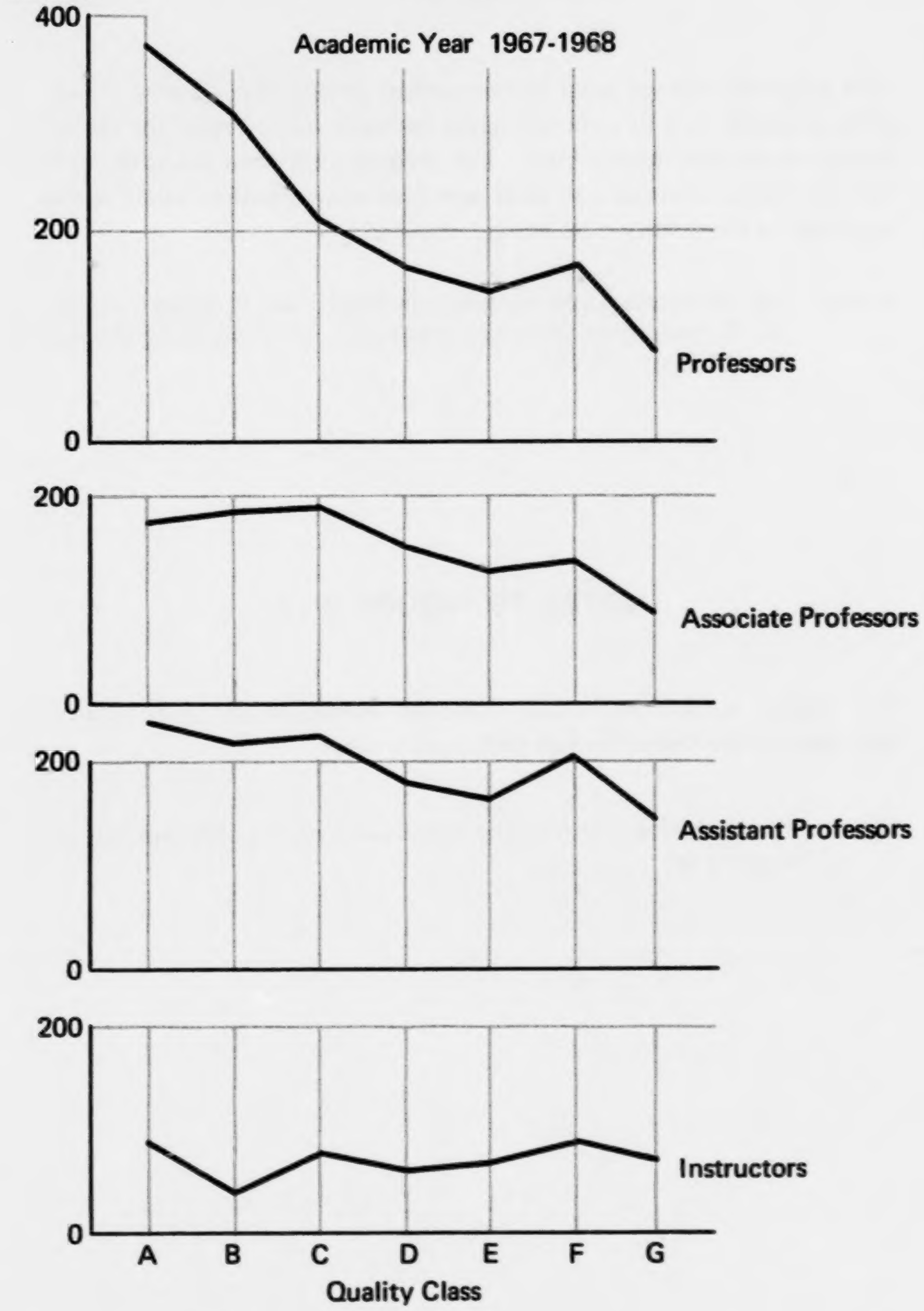
Academic Year 1967-1968



See notes following Figure 2-17. The compensation amounts denote weighted averages.

Figure 2-17

NUMBER OF FACULTY MEMBERS BY RANK



See notes on following page.

NOTES TO FIGURE 2-16

The weighted average total compensation (salary plus employee benefits, adjusted to a nine-month basis) for each faculty rank for the institutions of each quality class. The weights used were the total number of faculty members at each specified compensation level, at the rank and in the quality class being computed.

Source: The 1967-1968 AAUP compensation survey. *AAUP Bulletin,* vol. 54, no. 2, Washington, American Association of University Professors, June 1968, pp. 182-241.

NOTES TO FIGURE 2-17

The median number of faculty members, computed for each faculty rank and for the institutions of each quality class.

Source: The 1967-1968 AAUP faculty compensation survey. See also note to Figure 2-16.

sation of the associate professor also exhibits a regular pattern, but the range is considerably less, and it must be regarded only as a weak correlate of quality. For the other two ranks no clear pattern can be discerned; the compensation of these ranks is not a correlate of quality.

The significant conclusion, therefore, is that **the quality of the institution reflects the compensation of the full professors.** Inter-university competition for faculty relies heavily on institutional prestige and research opportunity at the lower ranks; after scholarly promise has become scholarly attainment, the competition, in far greater measure, becomes a financial one.

FACULTY STRUCTURE

A similar situation prevails for the numbers, absolute or relative, of faculty members in different ranks, as illustrated in Figure 2-17. For the full professor, the pattern is uniform, with the exception of Class F, and the number of full professors is clearly a correlate of quality. The number of associate professors, however, is at best a weak correlate; that of the assistant professors and instructors does not appear to have quality significance. Several useful relationships can be computed:

1. The ratio of the number of professors to the number of associate professors, as shown in Table 2-1, is clearly a correlate of quality; that of assistant professors to instructors is considerably weaker. Nor does the ratio of associate professors to assistant professors have quality implications. The significance of the full professor is again emphasized, while the relatively low position of the number of instructors for the higher quality classes reflects the disappearance of this rank and its replacement by the assistant professorship for first appointments.
2. A useful pattern is seen in Table 2-2. The relative position of assistant professor, associate professor, and instructor appears to be an invariant, independent of quality. The position of professor, relative to these three, however, declines drastically as quality decreases.

Table 2-1

RELATIONSHIPS AMONG FACULTY RANKS

	Median Ratios of Numbers of Faculty		
Quality Class	Professors ÷ Assoc. Professors	Assoc. Professors ÷ Ass't. Professors	Ass't. Professors ÷ Instructors
A	2.09	0.65	3.07
B	1.56	0.90	4.02
C	1.20	0.79	2.61
D	1.08	0.90	2.50
E	1.04	0.72	2.32
F	1.18	0.90	1.97
G	1.08	0.64	2.52

Source: Computed from the 1967-1968 AAUP faculty compensation survey. See also note to Figure 2-16.

Table 2-2

FACULTY DISTRIBUTIONAL PATTERNS

Groups of Quality Classes	Number of Faculty in Descending Order
A, B	Professors (largest number) Assistant Professors Associate Professors Instructors (smallest number)
C, D, E, F	Assistant Professors Professors Associate Professors Instructors
G	Assistant Professors Associate Professors Professors Instructors

Source: Based on the medians shown in Figure 2-17.

Table 2-3

FULL PROFESSORS AS A PERCENTAGE OF TOTAL FACULTY

Quality Class	Median Percentage
A	42
B	38
C	32
D	30
E	27
F	28
G	28

Source: Computed from the 1967-1968 AAUP faculty compensation survey.
See also note to Figure 2-16.

3. The quality significance of the full professor is summarized in Table 2-3. The pattern of professors as a percentage of total faculty decreases uniformly through the first five classes. The percentages for Classes F and G suggest that a minimum value may have been reached, a matter that should receive further investigation.

Of interest is the relatively large number of faculty of all ranks for Class F (See Figure 2-17), while the compensation pattern (See Figure 2-16) remains consistently low, except for instructors. The implication is that the institutions of this class may be attempting to build faculties without regard for the quality inherent in the potential of improved compensation policies. Similarly, Class E is relatively and consistently low on both numbers and compensation of faculty. The large student-faculty ratio for this class, noted above and in Figure 2-18, thus appears to imply an inability to build the faculty, either in numbers or quality. This conclusion is confirmed by the position of Class E in Figures 2-3 and 2-4.

Again, the significant conclusion is that, as far as the number of faculty can contribute, **the quality of the institution reflects the number of full professors.**

STUDENT-FACULTY RATIO

It is generally held that education of higher quality is accompanied by lower student-faculty ratios. In fact, if such a ratio is computed for entire institutions, that is, total student body divided by total faculty, the resulting medians do indeed decrease as quality increases, on the testing scale used in this report.[24] However, such an overall ratio is heavily influenced by the numerically larger undergraduate divisions of universities. Any distinctive behavior of this ratio in the graduate divisions is thus camouflaged.

If an overall **graduate** student-faculty ratio is computed, on the basis of full-time students and faculty only, the results are reversed. This is illustrated in Figure 2-18. **As the quality**

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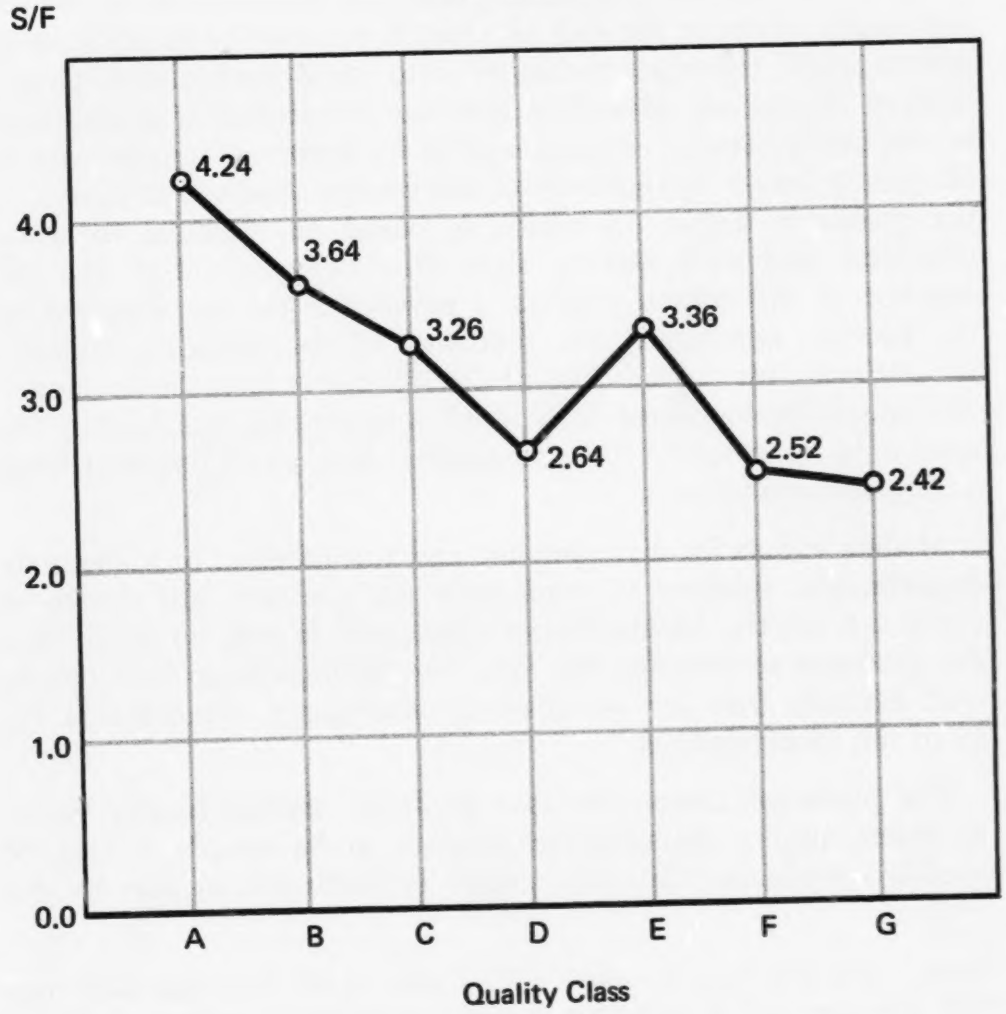
[24] From data furnished by the Office of Education (DHEW) and data contained in *Opening Fall Enrollment in Higher Education, 1963*, Publication No. OE-54003-63, Washington, Office of Education (DHEW), 1963, the student-

Figure 2-18

GRADUATE STUDENT-FACULTY RATIO

Science and Engineering

Fall 1966



The median ratio of full-time graduate students to full-time graduate faculty for the institutions of each quality class. All academic disciplines are combined.

Source: Departmental data submitted by institutions in application to the Graduate Traineeship Program, Division of Graduate Education in Science, National Science Foundation. See also notes to Figures 2-11 and 2-12.

of the graduate program in science and engineering increases, so does the student-faculty ratio; the pattern is moreover regular, with the exception of Class E, discussed previously. The graduate student-faculty ratio is thus a quality correlate of the graduate program.

From available data concerning graduate departments in science and engineering for the Fall of 1966, it is possible to examine in greater detail this student-faculty ratio for individual disciplines. Sixteen disciplines, identified with the departmental evaluations of the Cartter study, are represented by reported departments at all quality levels. A summary of the results obtained is shown in the profile in Table 2-4 which is based on medians for each discipline and each quality class. It should be noted that the number of disciplines reaches a maximum on the diagonal of the pattern, confirming the tendency of the graduate student-faculty ratio, for the majority of disciplines, to increase as departmental quality increases. This trend is further summarized by the median of the medians for each quality class, again demonstrating a fully uniform pattern.

Median values for distinguished and for marginal or inadequate departments, selected to emphasize the contrast, are shown in Table 2-5 for the 16 disciplines examined. It will be noted that the graduate student-faculty ratio for distinguished departments well exceeds that for marginal or inadequate departments for 15 of the 16 disciplines.

The principal reason for low graduate student-faculty ratios in lower quality departments appears to be simply a lack of qualified students. This explanation is confirmed in part by the

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faculty ratio has been computed as the ratio of full-time-equivalent (full-time plus one-third of part-time) students to full-time-equivalent faculty:

Quality Class	Student-Faculty Ratio (Median)
A	10.0
B	11.5
C	12.0
D	14.0
E	13.5
F	14.0
G	16.0

Table 2-4

SUMMARY GRADUATE STUDENT-FACULTY RATIO PROFILE - 16 DISCIPLINES

Fall 1966

Median Student-Faculty Ratio	Quality Class of Departments (1)				
	D	S	G	A	O
Highest Ratio	8	3	3	2	0
Next to Highest	5	5	1	4	1
Middle	2	4	6	3	1
Next to Lowest	1	3	5	7	0
Lowest Ratio	0	1	1	0	14
No. of Disciplines	16	16	16	16	16
Median of Median Ratios	4.72	3.78	3.59	3.48	2.83

(1) See Allan M. Cartter, *An Assessment of Quality in Graduate Education,* Washington, American Council on Education, 1966.

D: Distinguished
S: Strong
G: Good
A: Adequate - plus
O: Other (marginal or inadequate)

Source: Departmental data submitted by institutions in application to the Graduate Traineeship Program, Division of Graduate Education in Science, National Science Foundation. See also notes to Figures 2-11 and 2-12.

Table 2-5

MEDIAN GRADUATE STUDENT- FACULTY RATIOS FOR 16 DISCIPLINES

Fall 1966

Discipline	Distinguished Departments	Marginal or Inadequate Depts.
Sociology	7.33	3.25
Chemistry	6.11	3.80
Political Science	5.88	3.00
Geography	5.84	2.58
Chemical Engineering	5.49	2.80
Electrical Engineering	5.44	2.89
Microbiology	(5.18)(1)	2.86
Anthropology	4.91	3.30
Physics	4.53	2.91
Geology	4.13	2.34
Economics	3.80	2.17
Civil Engineering	3.66	2.44
Mathematics	3.50	2.30
Mechanical Engineering	3.43	1.93
Botany	2.96	2.56
Astronomy	2.39	3.14

(1) Data reported for only one department

Source: See notes to Table 2-4

pattern of Figure 2-10 which illustrates dramatically the pressure by the better students for admission to the better graduate programs. Only in the case of the early years of a rapidly developing graduate program of high quality, marked by the aggressive formation of a high quality faculty, would a relatively low ratio be anticipated, prior to the achievement of a steady state of faculty and students. Conversely, as already noted for Class E, a relatively high student-faculty ratio could result from the admission of students of indifferent quality, while the institution lacks the resources or the policies to build its faculty to a satisfactory level. In general, the data that have been tabulated suggest that institutions have achieved a balance between their graduate faculties and the available students at available quality, a matter that is at least partially subject to the policies of the institution. On the other hand, the implications of the graduate student-faculty ratio in relation to the growth of graduate enrollments during the next decade should receive careful examination. A further reason why higher student-faculty ratios could be expected in higher quality graduate departments is suggested in the next section.

MINIMAL SIZE

It is frequently stated that a graduate program or department must exceed a certain size, if it is to be of high quality. This size is sometimes referred to as a "critical" size, although the only number that is critical would appear to be unity (1), denoting the very existence of the program or department. The term "minimal size" is used in this report simply to reduce any possible connotation that a sudden change occurs when a certain number is attained. Most commonly, the concept is used to refer to the number of faculty members.

Although academic disciplines vary widely in the characteristic size of departments, there appears to be no inherent reason in the disciplines themselves to require that this be so, except for variations in the numbers of specialists that actually prevail. Instead, it would seem appropriate to seek the reason for a minimal size in the social psychology of small groups, that is, in the nature and interactions of people.[25]

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[25] See for example a review article by E. J. Thomas and C. F. Fink (reprinted in *Small Groups—Studies in Social Interaction*, edited by A. P. Hare,

In order to provide a primitive theoretical model to assist in numerical estimation, a rationale is suggested that is based on the mutual strengthening that results from communication among the members of a peer group.[26] This strengthening is due in large part to the fact that no individual can be expert in all of the aspects and subdisciplines of a field. Through communication the skills, knowledge, experience, and judgment of each member are shared and made useful to others. Mutual reinforcement extends especially to the interactions among intra-disciplinary specialists working on different topics of what is nominally the same scientific subdiscipline. Together, such a group of peers is more than the sum of its parts.

A measure of this group effect is thus assumed to reside in the number of communicational opportunities presented by the group: individuals working alone, conversations involving two or three members, and so on up to meetings involving the entire group.[27] A basis for the concept of minimal size is thus sought in some distinctive feature of the marginal increase in the number of communicational opportunities as one more member is added to the group. It is seen that there is indeed a definable difference between groups with from one to about six members and groups with at least seven members.

> **It is tentatively concluded, therefore, that a high quality academic department will contain approximately seven or**

E. F. Borgatta, and R. F. Bales, New York, Alfred A. Knopf, 1965, pp. 525 ff.). Commenting on a number of experimental studies that have been conducted:

> Considering the group performance findings as a whole, it appears that both quality of performance and group productivity were positively correlated with group size under some conditions, and under no conditions were smaller groups superior.

[26] A similar basis, involving types of relationships among the members of a group and addressed to the problem of span of control in industrial organizations, was used by V. A. Graicunas, *Relationship in Organization*, Bulletin of the International Management Institute, 1933, pp. 39-42. (Reprinted in L. Gulick and L. Urwick, eds., *Papers on the Science of Administration*, New York, Columbia University, Institute of Public Administration, 1937, pp. 183-187.)

[27] This number is computed as a binomial series. It approaches an asymptote where the addition of one more member simply doubles the

> **more faculty members,** a communicating group of peers. Confirmation of this conclusion is found in a review of more than 1000 departments in 20 disciplines of science and engineering. The result is shown in Figure 2-19 where departments are sorted in accordance with their rating in the Cartter study. High quality departments tend to be large departments. The converse, however, is not true; the achievement of adequate size is necessary but not sufficient for the attainment of high quality.
>
> The same argument also provides a possible basis for anticipating an increase in the student-faculty ratio in graduate departments as quality increases. The students associated with a faculty member also constitute a peer group. Accordingly, as quality increases, the student-faculty ratio would be expected to approach seven or more, a value that is ultimately dictated by the availability of students and the requirement that a tutorial relationship exist between the graduate student and the faculty member. This conclusion appears to be supported by the evidence discussed above concerning the student-faculty ratio.

No attempt is made to address the corresponding matter of maximal or even optimal size. As size increases subdivisions occur. These subdivisions may be informal, through the establishment of smaller communicating groups, or formal, through the

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number of communicational opportunities. The way in which this asymptote is approached is as follows:

N Number of Members	C Number of Combinations	Ratio: C^N/C^{N-1}	Difference
0	0		
1	1	∞	
2	3	3.00	∞
3	7	2.33	0.67
4	15	2.14	0.19
5	31	2.07	0.07
6	63	2.03	0.04
7	127	2.02	0.01
8	255	2.01	0.01
9	511	2.00	0.01
10	1023	2.00	0.00

Figure 2-19 →

NUMBER OF FACULTY MEMBERS PER DEPARTMENT

Fall 1966

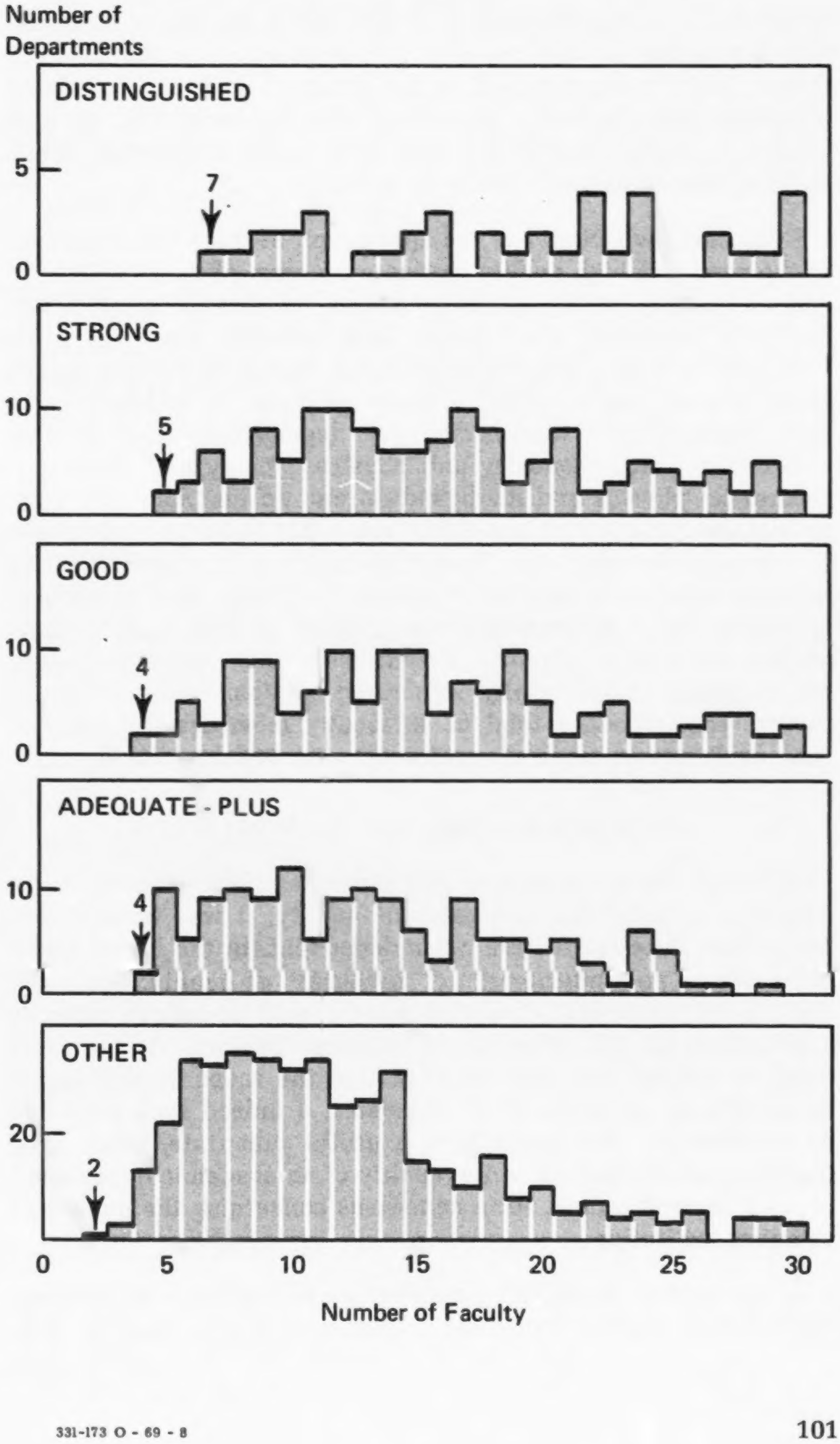
NOTES TO FIGURE 2-19

The number of departments of each quality class in 20 disciplines combined considered as a function of the number of full-time graduate faculty members. The distributional pattern is summarized as follows:

Quality Class	No. of Faculty per Department		Percent of Departments with more than 30 Faculty Members	Total No. of Departments
	Minimum	Median		
D	7	28.5	42.7	68
S	5	20.0	28.1	192
G	4	16.0	9.2	152
A	4	13.0	5.3	152
O	2	11.0	0.7	439
				1003

Quality classes refer to the departmental ratings in A. M. Cartter, *An Assessment of Quality in Graduate Education (op. cit.).* See notes to Table 2-4. The 20 disciplines are included among the science and engineering disciplines of the Cartter study.

Source: Departmental data submitted by institutions in application to the Graduate Traineeship Program, Division of Graduate Education in Science, National Science Foundation.


Number of Departments
DISTINGUISHED
5
0
7
STRONG
10
0
5
GOOD
10
0
4
ADEQUATE - PLUS
10
0
4
OTHER
20
2
0
5
10
15
20
25
30
Number of Faculty

creation of sub-departments. It is possible to speculate, however, that the region of minimal size, in its relation to the student-faculty ratio, is approached in the graduate and undergraduate programs from opposite directions (See Footnote 24). In high quality graduate departments this ratio tends to increase, while the undergraduate ratio tends to decrease.

Even more speculative is the application of this same argument to the need in a high quality graduate program of an allied, hence communicating, group of departments in closely related and mutually dependent disciplines. This becomes the large scale counterpart of the mutual strengthening, noted above, that results from communication within a group of peers. In addition, however, there is also interdisciplinary dependence, such as that between physical chemistry and physics, biology and chemistry, theoretical physics and mathematics, and so on. Although communication between groups differs from that between individuals, if one considers that such interaction consists of communication between individuals within the respective groups, it is possible to speculate that a **minimal** doctoral program of high quality might contain at least 7 graduate departments (i.e., minimal groups, not formally or informally structured groups, each containing diverse specialties), a total of 49 faculty members (typically of rank professor or associate professor), and 343 doctoral students.

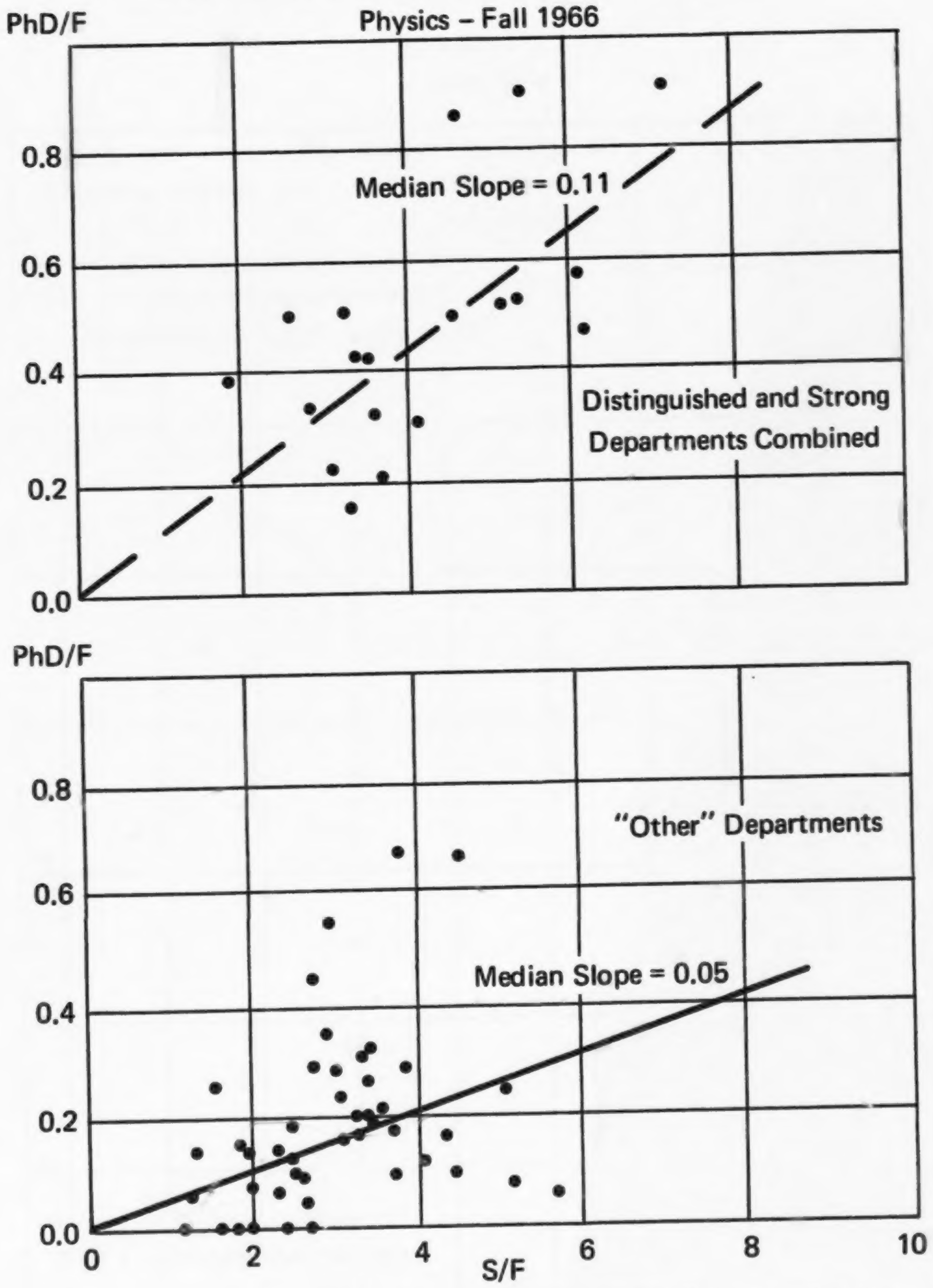
COMBINATIONS OF CORRELATES

Although the discussion to this point has been directed to the behavior of individual correlates of quality, it was noted previously that these factors are not independent. In the literal sense, there can be no "indicators" or "measures" of quality. Similarly, there is no "correlate" of quality which, used alone, can serve as a substitute for the judgment of informed persons. At the same time, no attempt has been made within the scope of this report to identify an optimum set of correlates, if indeed such a set can be constructed, that might form a useful substitute, when used together, for a judgment of the quality of an academic department or, as a derived notion, for a consensus concerning the quality of an entire institution.

In a practical sense, all parameters are mutually reinforcing. For a lower quality institution to aspire to higher quality, it is

Figure 2-20

RELATIONSHIP OF QUALITY, DOCTORAL PRODUCTIVITY PER FACULTY MEMBER, AND GRADUATE STUDENT-FACULTY RATIO



To illustrate quality separation and departmental diversity using two quality correlates simultaneously.

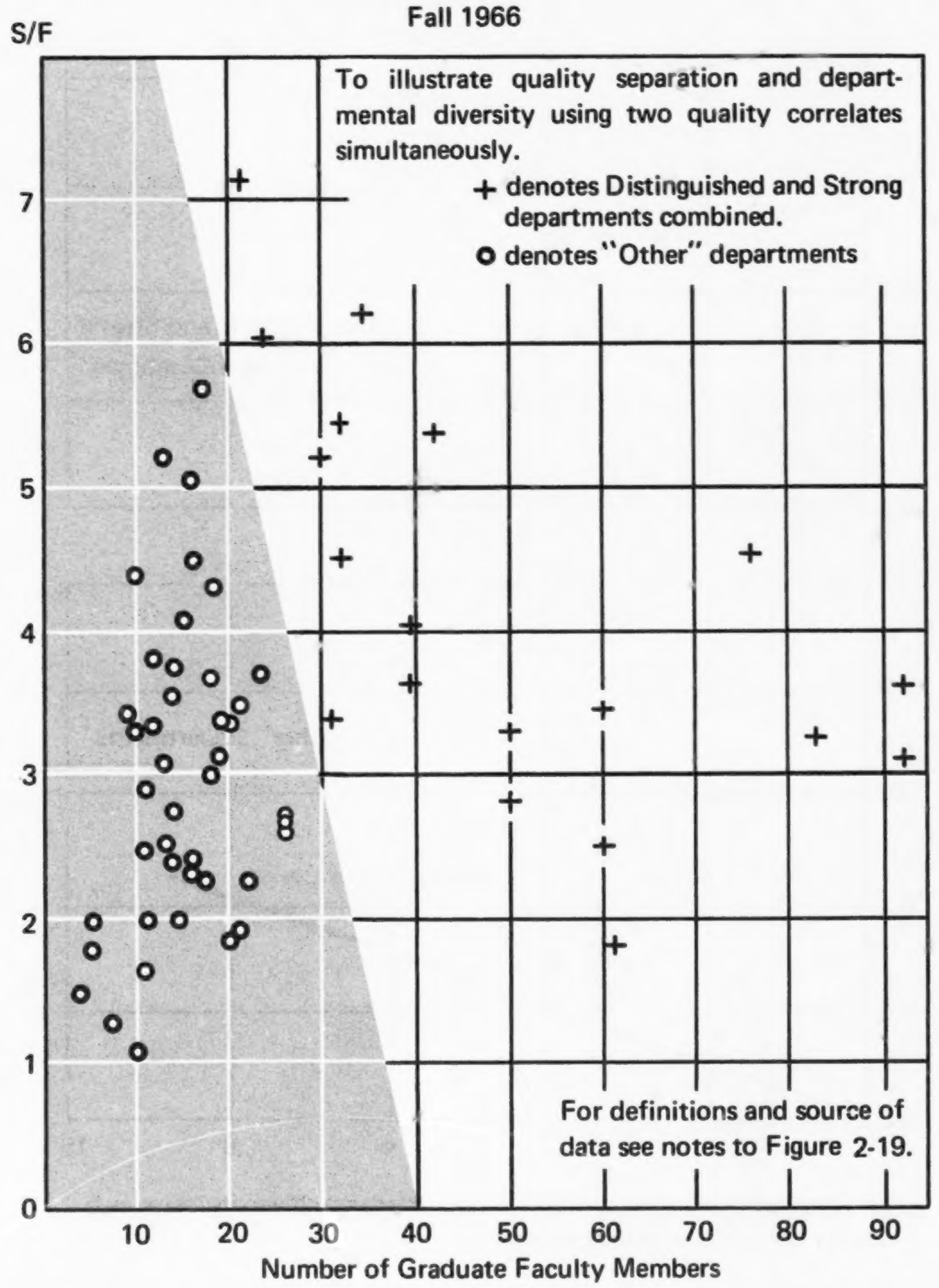
For definitions and source of data see notes to Figure 2-19.

Figure 2-21

RELATIONSHIP OF QUALITY, GRADUATE STUDENT-FACULTY RATIO (S/F), AND NUMBER OF GRADUATE FACULTY MEMBERS

Physics

Fall 1966



To illustrate quality separation and departmental diversity using two quality correlates simultaneously.

+ denotes Distinguished and Strong departments combined.

o denotes "Other" departments

For definitions and source of data see notes to Figure 2-19.

clearly necessary to begin with adequate financial resources and to assemble the appropriate faculty and facilities. Facilities, faculty, and students will grow more or less in parallel, and all other correlates of quality, in time, will reflect the progress. There is no substitute for this spiral to success.

> Two examples of the effect of combinations are illustrated in Figures 2-20 and 2-21. Physics was chosen as a prototype discipline in which a large number of departments was reported. In Figure 2-20 two correlates, doctoral productivity per faculty member and graduate student-faculty ratio, together are seen to yield a better separation of high quality and low quality departments than either measure, considered alone. Similarly, in Figure 2-21, full separation of high quality and low quality departments is obtained by considering together the student-faculty ratio and the number of faculty members per department. This procedure resulted in minimum overlap for each of the 20 disciplines examined.

THE MEDIAN INSTITUTION OF HIGH QUALITY

In the foregoing discussion twenty correlates of institutional quality have been reviewed, in addition to several that relate only to individual departments. These twenty factors, however, are of two general types: factors that are directly involved in the doctoral programs of the institution, and others that measure aspects of the entire institution, its undergraduate division, or its master's degree programs, and hence that are only indirectly related to work for the doctorate. Although all of these factors have been demonstrated to be correlates of quality in the graduate program, with varying degrees of success, they cannot all be considered to characterize such a program. Accordingly, these correlates are summarized in Table 2-6 for the purposes of (a) distinguishing between these two types, (b) distinguishing further between factors that simply measure magnitudes and others, such as ratios, that are independent of size, and (c) ordering the factors in each of these four classes on the basis of the ratio of the value for Class A to that for Class G, thus providing a rough indication of the relative effectiveness of each. It should be noted that the most powerful doctorate-related factors appear to involve the response of several sectors of the public to the graduate program

Table 2-6

SUMMARY OF CORRELATES

A/G (1) (Magnitudes)	Direct Relation to Doctoral Program	A/G (Magnitudes)	Indirect or No Relation to Doctoral Program
362.0 (2)	Choice by Fellowship Recipients	9.3	BS Origins - Fellowship Recipients
29.0	Postdoctoral Students	8.0	BS Origins - Doctorates
25.1	Federal Research Project Grants	5.6	Non-Federal Current - Fund Income
7.2	Doctoral Awards	3.8	Master's Degree Awards
4.2	Professors		
1.9	Associate Professors		
(Ratios) (3)		(Ratios) (3)	
4.60	PhD / Baccalaureates	2.40	MS (or MA) / Baccalaureates
3.22	PhD / Faculty	2.26	BS Origins / BS
2.22	PhD / Students	1.83	Fellowship Awards/ Applicants
1.75	Students / Faculty	1.31 (4)	Freshman Admissions Selectivity
1.40 (4)	Compensation - Professors		
1.16 (4)	Compensation - Associate Professors		

(1) The (median - where applicable) value for Quality Class A divided by that for Class G.

(2) The ratio is Class A/Class F, since the value for Class G is zero.

(3) Several of the factors listed are not strictly ratios.

(4) The relatively small value is misleading since the range for the factor is necessarily small.

Table 2-7

QUALITY CLASSES AND FACTOR POSITION AVERAGES (1)

Quality Class	Position for Uniform Pattern	Types of Factors	
		Direct Relation to PhD Program	Indirect Relation to PhD Program
A	1	1.2	1.0
B	2	2.0	2.1
C	3	2.9	3.4
D	4	4.4	5.1
E	5	4.9	4.1
F	6	5.8	5.9
G	7	6.8	6.5

(1) The average position of the (median) values for the quality class in question relative to those for the other six quality classes. Thus, 1.0 for Class A means that the values for Class A are the largest for ALL correlates of the type considered.

(magnitudes) and the doctoral productivity of the graduate program in terms of institutional commitment and faculty effectiveness (ratios).

That the distinction between the two classes of factors (doctorate-related and others) is significant is suggested in Table 2-7 where the average value of the relative position of the factors of each type is shown. For the doctorate-related correlates the pattern is regular and approximates the simple ordering 1, 2, 3, . . . In fact, the average value 1.2 for Class A would become 1.0 if the number of associate professors were discarded as a factor. On the other hand, for the correlates that are only indirectly related to the doctoral program Classes D and E actually exchange places. The anomalous behavior of Class E, noted previously, thus becomes clear. The institutions of Class E are relatively old institutions. They have remained, however, predominantly undergraduate institutions, of moderate quality, with large master's degree programs. They have not been successful in gaining the financial resources necessary to undertake a doctoral program of comparable quality. There is thus a paucity of senior faculty, while the large graduate student-faculty ratio reflects the master's degree program rather than a high quality doctoral program.

Median values that have been obtained for the twelve doctorate-related factors are listed in Table 2-8 for Classes A and B. Apart from the fact that these factors, especially those that are magnitude dependent, are based on conditions prevailing several years ago, this array provides a convenient, albeit rough, yardstick for the appraisal of the graduate programs of individual institutions in overall perspective. **It should be emphasized again that the simulation of the values of a group of factors will not ensure a graduate program of high quality.** It is difficult to visualize a situation, however, in which a graduate institution of poor quality will meet or exceed the values listed in Table 2-8 for all or even a majority of the factors shown.

THE COST OF QUALITY

All graduate institutions seek to improve the quality of their programs. Because of the importance of high quality graduate education to the future of this Nation, it is appropriate to consider the cost of undertaking new graduate programs at the doctoral level and of upgrading existing ones. In principle, the factors that have been reviewed provide a means for estimating the financial resources that such plans entail. The numbers, distribution, and compensation of the faculty provide a possible basis for estimating the cost involved in quality improvement. However, total faculty compensation, considered as a percentage of total expenditures for educational and general purposes, is itself a correlate of quality.[28] For this reason an estimate will be based on the median current-fund expenditures for educational and general purposes for the institutions of each quality class, in effect a combination of Figures 2-3 and 2-4.

Table 2-8

SUMMARY OF CORRELATES FOR MEDIAN GRADUATE INSTITUTIONS OF HIGH QUALITY (1)

	Class A	Class B
Number of First-Time NSF Graduate Fellowship Recipients (2)	72	12
Number of Postdoctoral Students in Science and Engineering	174	84
Federal Research Project Grants (thousands)	$22,878	$10,898
Number of Doctoral Awards Annually	316	205
Number of Full Professors	375	308
Number of Associate Professors	172	180
Ratio of Doctoral Awards to Baccalaureate Awards	0.202	0.110
Doctoral Awards per Member of Graduate Faculty	0.429	0.353
Doctoral Awards per Full-Time Equivalent Graduate Student	0.102	0.096
Graduate Student-Faculty Ratio	4.24	3.64
Nine Month Compensation - Full Professors	$18,838	$17,616
Nine Month Compensation - Associate Professors	$13,345	$12,829

(1) Correlates directly related to the doctoral program; values listed relate generally to the mid-1960's.

(2) An ANNUAL average based on Figure 2–10.

Table 2 - 9A

SUMMARY OF ESTIMATED 10-YEAR DEVELOPMENTAL EXPENDITURES FOR ONE-STEP QUALITY INCREASE

(constant dollars in millions)

		B to A	C to B	D to C	G to F
(i)	Annual Expenditures - Initial (1)	$ 63	$ 33	$ 22	$ 10
(ii)	Annual Expenditures - After 10 Years (2)	92	63	33	23
(iii)	Total 10-Year Incremental Expenditures for Quality Improvement and Expansion (3)	157	169	58	67
(iv)	Capital Cost of New Plant Required for Development (4)	16	8	13	10
(v)	Total Incremental Development Expenditures (5)	173	177	70	77
(vi)	Additional Annual Number of Doctoral Awards (6)	111	103	46	--
(vii)	Percent Increase in Doctoral Output	54%	101%	82%	--
(viii)	Developmental Cost per Unit Increase in Doctoral Capacity (7)	$1.6	$1.7	$1.5	--
(ix)	Developmental Cost per Doctorate (Doctoral Output at Terminal Quality) (8)	$0.55	$0.86	$0.69	$1.83

Table 2 - 9B

SUMMARY OF ESTIMATED 10-YEAR DEVELOPMENTAL EXPENDITURES FOR ONE-STEP QUALITY INCREASE

(current dollars in millions) (9)

		B to A	C to B	D to C	G to F
(x)	Annual Expenditures - Initial	$ 63	$ 33	$ 22	$ 10
(xi)	Annual Expenditures - After 10 Years (10)	184	127	65	45
(xii)	Total 10-Year Incremental Expenditures to Maintain Relative Quality Position (11)	313	161	110	51
(xiii)	Total 10-Year Incremental Expenditures for Quality Improvement and Expansion (12)	258	278	95	110
(xiv)	Capital Cost of New Plant Required for Development (13)	24	12	19	15
(xv)	Total Incremental Development Expenditures (14)	282	290	114	125
(xvi)	Total Incremental Expenditures over 10-Year Period (15)	595	451	224	177
(xvii)	Ratio of Developmental Expenditures to Incremental Expenditures to Maintain Position (16)	0.90	1.80	1.05	2.45

NOTES TO TABLE 2-9

(1) Median expenditures in academic year 1963-1964 for Educational and General Purposes by the institutions of each quality class.

(2) Same as (1) for the terminal quality class.

(3) Development from (i) to (ii) assumed to be linear over the 10-year period.

(4) Based upon the composition of the faculty (Figure 2-17), the appropriate student-faculty ratios (Figure 2-18), the appropriate numbers of postdoctoral students (Figure 2-11), an assumed norm of 250 square feet of net usable space per professional person at $55 per square foot, and construction occurring linearly over the 10-year period.

(5) Sum of line (iii) and (iv).

(6) See Figure 2-1.

(7) Line (v) divided by line (vi).

(8) Ratio of line (v) to terminal number of doctorates (See Figure 2-1).

(9) Based on an estimated 10-year doubling time for expenditures for graduate education at constant enrollment. The annual rate of 7.2 percent combines the effects of inflation (3 percent) and increased complexity in the educational and research processes.

(10) Equal to 200 percent of the appropriate figure in line (x).

(11) Based upon computation of annual increment, at 7.2 percent compounded, beginning at line (x).

(12) Based upon constant dollar computation, adjusted for 7.2 percent annual increase. Development is assumed to be linear (at constant dollars) over the 10-year period.

(13) Same as (4), adjusted for 7.2 percent annual increase assumed to apply to facilities as well as operations.

(14) Sum of lines (xiii) and (xiv).

(15) Sum of lines (xii) and (xv).

(16) Ratio of line (xv) to line (xii).

A realistic plan could be directed towards improving the quality of the graduate program by transition to the next higher quality class over a 10-year period. Rough estimates of the financial requirements are summarized in Table 2-9 both for constant dollars and current (inflated) dollars. Transitions involving Class E have been omitted. In each instance it is assumed that the **median** institution of the class will be transformed into the **median** institution of the next higher class.

There are three conclusions of interest:

1. Although the developmental cost is greater for transitions from the higher quality classes (See Table 2-9A, line v), the cost per unit **increase** in doctoral output at higher quality is approximately constant for transitions from Classes B, C, and D (See Table 2-9A, line viii); this unit cost, however, will increase at the lower quality classes because their smaller doctoral output is relatively insensitive to quality (See Figure 2-1).
2. The developmental cost per unit doctoral output at higher quality, the terminal situation, is smaller for transitions from the higher quality classes (See Table 2-9A, line ix).
3. If development is assumed to occur under conditions of inflation and increasing complexity, the developmental cost for transition from the **highest quality class** represents the **smallest** fraction of the incremental expenditures that are necessary to maintain constant quality (See Table 2-9B, line xvii).

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[28] Using available figures, the ratio of total faculty compensation in 1967-1968 for the median institution of each quality class to the median current-fund expenditures for educational and general purposes in 1963-1964 is (omitting Class E):

Class A	0.136
B	0.163
C	0.265
D	0.293
F	0.299
G	0.408

NOTES TO FIGURE 2-22

Census Division	Percent of Graduate Students in Class A, B, or C Institutions	Graduate Students per 100,000 Population	Number of Class A, B, or C Institutions
Pacific	56.2	302	8
East North Central	53.4	264	10
West North Central	45.7	233	5
Mid Atlantic	45.5	344	13
New England	30.5	394	5
South Atlantic	22.5	192	4
Mountain	19.4	321	1
West South Central	15.8	205	3
East South Central	5.3	121	1

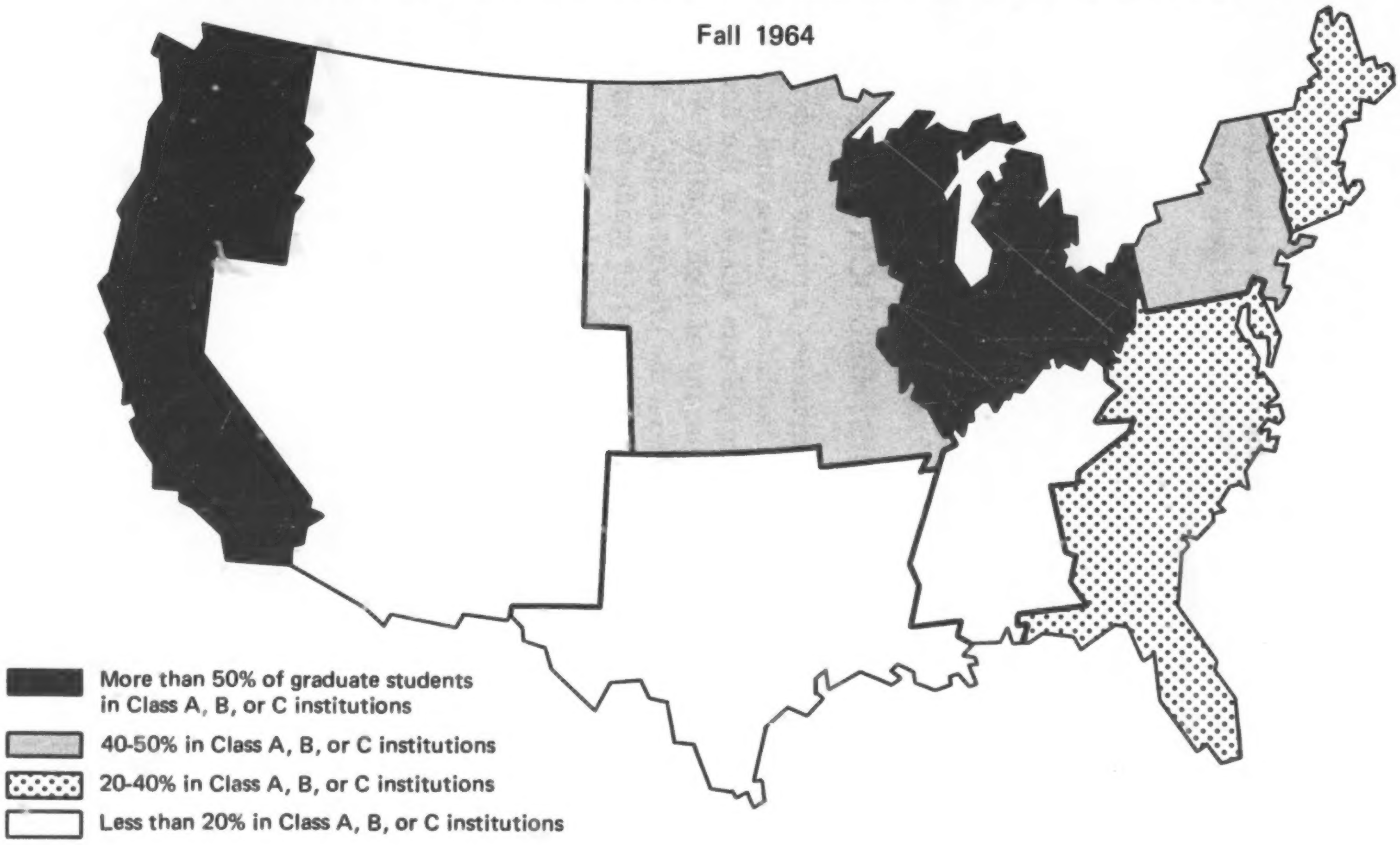
U. S. TOTAL	
40.2%	in Class A, B, or C institutions
265	graduate students per 100,000 population
50	Class A, B, or C institutions

Source: Population figures from 1960 Census; information on graduate enrollments, Fall 1964, from Office of Education (DHEW).

Figure 2-22

GEOGRAPHICAL DISTRIBUTION OF GRADUATE INSTITUTIONAL QUALITY

Fall 1964


■ More than 50% of graduate students in Class A, B, or C institutions
▨ 40-50% in Class A, B, or C institutions
⁘ 20-40% in Class A, B, or C institutions
☐ Less than 20% in Class A, B, or C institutions

Both in terms of the ultimate quality of the doctorates produced and the relative efficiency in the use of developmental funding, more is accomplished by upgrading institutions in Classes B, C, and D than those farther down the quality scale, a conclusion of the utmost importance in the formulation of public policy concerning where public funds shall be placed in developing the quality of graduate education. That the decision, however, is not a simple one will be seen in the following sections.

The same procedure can be used to estimate the total funding required to build a **new** Class A institution over a period of 10 years. Using current dollars, the total becomes approximately $930 million, including $96 million for graduate facilities. In constant dollars this is about $506 million, including $64 million of facilities.

GEOGRAPHICAL DISTRIBUTION OF QUALITY

Quite apart from cost-effectiveness, a prime consideration is the extent to which citizens, communities, States, and regions of the United States have access to and can share in the benefits to be derived from graduate institutions of high quality. A measure of this interaction is available from the present analysis. There are in the United States (1964 data) a total of 50 graduate institutions in Classes A, B, and C, with 191,396 graduate students. This total enrollment is 40.2 percent of the Nation's total graduate enrollment of 475,894 (part-time and full-time). The total national enrollment represents 265 graduate students per 100,000 population. The geographical distribution of graduate students in Class A, B, or C institutions has been, however, exceedingly uneven, as has been the chance that a graduate student in a given locality would be enrolled in such an institution. This situation is illustrated in Figure 2-22 for the nine census divisions of the United States. In only two regions has the graduate student better than an even chance of being enrolled in a Class A, B, or C institution; in three census divisions the odds are more than four to one against him.

A different aspect of the distribution is shown in Table 2-10 in which the percent of the Nation's graduate enrollments in Class A, B, or C institutions in a census division is compared with the percent of all graduate students in the United States and with the

Table 2 - 10

GEOGRAPHIC COMPARISON OF POPULATION AND GRADUATE ENROLLMENTS

Census Division	Percent of U. S. Graduate Enrollments in Class A, B, or C Institutions	Percent of U. S. Graduate Enrollments	Percent of U. S. Population
Mid Atlantic	28.0	24.7	19.0
East North Central	26.7	20.1	20.2
Pacific	18.8	13.5	11.8
West North Central	8.6	7.5	8.6
New England	6.6	8.7	5.9
South Atlantic	5.9	10.5	14.5
West South Central	2.9	7.3	9.5
Mountain	2.2	4.6	3.8
East South Central	0.4	3.1	6.7

Source: Population figures from 1960 Census; information on graduate enrollments, Fall 1964, from Office of Education (DHEW).

percent of the United States population. It will be noted that the shape of the resulting profiles reverses as the percent of graduate enrollments in Class A, B, or C institutions declines. These profiles provide a means for estimating the deficits, in terms of numbers of Class A, B, or C institutions, in these census divisions. If it is assumed that a region should have a percentage of the Nation's graduate enrollments in these high quality institutions at least equal to its percentage of all graduate enrollments or its percentage of the United States population, whichever is higher, then, since there is an average of 3,830 graduate students in each of the Class A, B, or C institutions, minimum developmental goals become:

Required Additional Class A, B, or C Institutions	
New England	1
South Atlantic	4
West South Central	3
Mountain	1
East South Central	3
	12

It should be noted, however, that the boundary between Class C and Class D institutions is relatively arbitrary, while the present review does not take account of developmental activities since 1964, especially in institutions omitted from the 106 universities of the Cartter study; the figures above should thus be considered illustrative rather than prescriptive.

PROJECTION BY QUALITY CLASSES

In principle, each quality class of institutions could be used as the basis for projecting doctoral output to academic year 1980-1981. There is, however, little information available on planned development or expansion by individual institutions, and hence on growth rates. For this reason it has seemed preferable to project on the graphical basis used in Chapter I and to examine the implications of this projection with respect to quality classes. Thus it is assumed that approximately 38,000 doctorates will be awarded in academic year 1975-1976 and about 48,000 in 1980-1981. A summary of the outlook is presented in Table 2-11.

A continuation of the average annual growth rates that prevailed for each quality class between the years 1955-1956 and

3

Table 2 - 11

PROJECTION OF DOCTORATE OUTPUT (1)

Quality Class	Percent of Total (2)			Annual Rate of Growth (3)	
	1964-65	1975-76	1980-81	1956 to 1965	1976 to 1981
A	32.4 %	23.7 %	19.8 %	4.8 %	1.5 %
B	19.7	16.0	14.3	5.8	2.7
C	17.9	19.0	19.5	8.4	5.7
D	10.5	12.4	13.2	9.5	6.1
E	6.9	8.0	8.5	9.4	6.3
F	3.3	3.1	3.0	7.4	3.4
G	2.2	2.8	3.0	10.1	5.7
Other (4)	7.1	14.8	18.3	15.2	9.6

(1) The 1975-76 total is estimated to be 37,600 doctorates; this figure is based on the actual 1964-65 total of 16,467 and the growth rates from 1955-56 to 1964-65 for individual quality classes. The 1980-81 total is estimated to be 48,000 doctorates (See graphical projections in Chapter I).

(2) The 1964-65 percentages are actual; those for 1975-76 are computed. The 1980-81 percentages are obtained by graphical extrapolation from the 1964-65 and 1975-76 figures.

(3) The estimated growth rate from 1975-76 to 1980-81 is computed from total doctorate production and Percent of Total estimates for the two years

(4) Includes 118 institutions in 1964-65 (including the 106 institutions of the Cartter list, the United States total was 224). Assuming an average increase of 4.5 doctoral granting institutions per year, this total becomes 168 institutions in 1975-76 and 190 in 1980-81.

1964-1965 leads, in academic year 1975-1976, to the projected total of doctorates awarded. Thereafter, however, a significant decline in growth rates must occur, if the projected total for 1980-1981 is to be anticipated. This decline corresponds to a decline in the projected growth rates of graduate enrollment.

The important feature of Table 2-11 is the implication that the contribution of the institutions presently in Classes A and B, together, to total doctoral output will decline from 52.1 percent in academic year 1964-1965 to about 34.1 percent in 1980-1981, or from more than one-half of the total to about one-third, while the contribution from Classes E, F, G, and "Other" will increase from 19.5 percent to about 32.8 percent during the same period. In addition, the number of "Other" institutions can be expected to increase from 118 in 1964-1965 to about 190 in 1980-1981. In other words, **unless effective measures are taken, nearly one-third of the doctoral output in 1980-1981 will be produced by institutions that will be necessarily subminimal or otherwise of less than optimum quality.**

The issue of public policy, therefore, is whether or not the quality of graduate programs generally can be improved sufficiently during this time interval to offset the apparent decline in average quality that can be anticipated. It was seen in a preceding section that cost-effectiveness considerations suggest development from the top; it may be that considerations of the public interest, including geography, also require simultaneous development from the bottom.

SUMMARY

This discussion of graduate institutional quality began with a question of feasibility; it has ended with a question of necessity. During the course of the discussion it has become increasingly apparent that measurable properties of the institution can be usefully studied as reflections of the quality both of the graduate program and of the total institution. Twenty potential correlates of quality have been reviewed, in addition to one relating to departmental size; each appears to have useful diagnostic value. Since these diverse parameters are entirely consistent, as correlates of graduate educational quality, with the study of graduate departmental quality with which the review began, confidence in the usefulness of both the correlates and the study itself has been strengthened. The important conclusion is that the footprints of quality can be discerned everywhere within the institution.

The implications with respect to the student are serious. There is every indication that he will seek the highest quality institutions. If he fails to gain admission, is it in his or the Nation's interest that he attend a lower quality institution and obtain an advanced degree that represents less than the highest standards? If not, will the Nation ensure that the maximum opportunity of high quality is available to him? If he is not qualified for admission to a high quality institution, is it in his or the Nation's interest to provide a lower quality opportunity so that he may pursue educational goals of dubious value? The fact that present trends suggest a gradual diminution of average quality render these questions of more than academic importance.

(no p.122)

III

Financial Perspectives

The financial circumstances and practices of colleges and universities relating to graduate education, including especially their fiscal relationships with the Federal Government, have proved to be confusing and troublesome. The financial difficulties of academic institutions are not new and derive from the essential nature of such institutions, which differ from commercial enterprises in a fundamental sense. Industrial organizations are specifically enjoined, through their terms of incorporation, to generate profits through the provision of a product or public service; academic institutions are required to provide a public service through the expenditure of money.[1] As eleemosynary institutions the latter will necessarily find their income and expenditures in close balance. If income is less than expenditures, the institution is faced with the curtailment of its services and ultimately with bankruptcy; if income is greater than expenditures, the institution may properly be criticized for failure to provide the full public service of which it is capable.

Unusual problems arise, however, during a period of growth. The past century, especially for graduate education, may be characterized as a period of (a) continually increasing enrollments, (b) price inflation with only limited periods of remission, (c) increasing demand and diversity of opportunity for public service, (d) increasing "unit cost" for the performance of such service or for the graduate educational process itself, resulting from rapidly increasing knowledge and sophistication of technique, and (e) increasing competition throughout the economy for the resources of the institution, particularly the faculty, requiring adjustments by the institution to retain these resources.[2] The net result has been a continuously difficult financial posture, one that has been aggravated, especially since the Depression, not only by the large increase in the magnitude of student enrollments but also by the large relative increase, already noted in Chapter I, in graduate enrollments. As a consequence, the institution has frequently been forced to budget a deficit in the expectation that the necessary funds would be forthcoming. The way in which a significant and increasing fraction of this funding has been obtained, together with some of the principal implications and misunderstandings that have accompanied this effort, is the subject of this chapter.

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[1] For a discussion of the distinction between academic and commercial institutions and of the general characteristics of academic financial practice, see John Dale Russell, *The Finance of Higher Education*, Revised Edition, Chicago, The University of Chicago Press, 1954, Chapter III and especially pp. 46 ff.

INCOME RELATIONSHIPS

The gross pattern of income, representing the principal sources available to universities, is illustrated in Table 3-1 for Current-Fund Income for Educational and General Purposes. Omitted are income specifically identified with the physical plant and income associated with Auxiliary Enterprises, including dormitories and cafeterias. The figures, therefore, relate entirely to the educational process, including research, and its associated administration.[3] Over a 12-year period, during which income for educational and general purposes quadrupled for 146 publicly and privately controlled universities combined, four distinct trends may be observed:

STUDENT FEES

Payments for tuition and other fees by students have generally kept pace with the increase. These fees, representing primarily "ability to pay" within an affluent economy rather than a cost determination, continue to form a stable source of institutional income. As a "price of education" this source of income can be expected to reflect both increasing enrollments and increases in the general price level. It is not clear, however, that it can reflect significantly more than this,[4] especially

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[2] A recent review of the problems of institutional income and expenditure is presented by William G. Bowen, *The Economics of the Major Private Universities*, Berkeley, The Carnegie Commission on the Future of Higher Education, 1968.

Table 3-1

INCOME RELATIONSHIPS

Distribution of Current-Fund Income for Educational and General Purposes

PUBLIC UNIVERSITIES (1)

Year	Total (millions)	Student Fees	Federal Research	State	Other (2)
1951-1952	746	9.7%	N.A.	50.3%	N.A.
1953-1954	878	10.6	12.3%	51.4	25.7%
1955-1956	1,158	11.7	12.6	50.3	25.4
1957-1958	1,507	11.7	15.0	50.5	22.8
1959-1960	1,862	11.3	18.8	48.1	21.8
1961-1962	2,389	11.2	21.9	45.9	21.0
1963-1964	3,080	12.0	23.4	44.0	20.6

PRIVATE UNIVERSITIES (1)

Year	Total (millions)	Student Fees	Federal Research	State	Other (2)
1951-1952	478	30.3%	N.A.	7.0%	N.A.
1953-1954	520	34.2	20.9%	3.7	41.2%
1955-1956	625	35.1	20.9	3.6	40.4
1957-1958	789	35.1	23.3	2.9	38.7
1959-1960	1,030	32.9	29.6	2.9	34.6
1961-1962	1,336	32.1	32.5	3.0	32.4
1963-1964	1,669	29.7	35.2	2.7	32.4

(1) Includes 88 publicly and 58 privately controlled institutions
(2) Includes endowment earnings and gifts and grants from individuals, philanthropic organizations, business corporations, and other private sources, etc.

Source: Derived from data made available by the Office of Education (DHEW).

since the undergraduate portion necessarily represents a subsidy for the more expensive forms of education, such as graduate education, which are currently exhibiting the most rapid rates of growth. In fact, the relative decline of Student Fees since 1958 as a fraction of the total income of privately controlled universities may reflect the relative increase in graduate enrollments.

STATE SUPPORT

Income from State governments, even in publicly controlled universities, has declined over the time scale shown in Table 3-1 as a fraction of total income for educational and general purposes. This decline has occurred in spite of large increases in State and local appropriations for higher education. Although further large increases can be anticipated, there appear to be two reasons why the relative contributions of State and local governments may be self-limiting.[5] First, the public debt of

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[3] A source of uncertainty relates to university income associated with Federal Contract Research Centers. Thus the biennial reporting form of the Office of Education (DHEW), *Financial Statistics of Institutions of Higher Education*, specifically provides for the inclusion of information covering organized research expenditures in these centers. On the other hand, for example, the reported information for 146 universities for fiscal year 1963-1964 cannot be reconciled with the analysis in *Federal Support to Universities and Colleges, Fiscal Years 1963-1966*, Publication No. 67-14, Washington, National Science Foundation, 1967, prepared for the Office of Science and Technology. For example, it is clear that obligations by the National Aeronautics and Space Administration for the support of these centers is not included in the Office of Education data, while more than $100 million of such funding by the Atomic Energy Commission has also been omitted. Since at least part of the support of Federal Contract Research Centers relates to graduate education, it has been considered preferable to accept the figures reported to the Office of Education for time series and comparative financial analysis.

[4] A case for increasing tuition rates, on the other hand, and regarding them as a major source of the future income of institutions of higher education is made by Seymour E. Harris, *Higher Education: Resources and Finance*, New York, McGraw-Hill, 1962, Chapter 4, pp. 43 ff. See also p. xxi, Item 8, and Chapter 10, pp. 149 ff.

[5] For a general discussion of State support of higher education see Seymour E. Harris, *op. cit.*, Chapter 24, pp. 325 ff.

State and local governments has increased far more rapidly, as a percentage, than has the Federal debt, while revenues have generally followed the Gross National Product; in contrast, institutional expenditures for educational and general purposes have risen faster than the Gross National Product. Secondly, a far smaller part of State and local revenues is derived from personal and corporate income taxes than is the case for the Federal Government, a circumstance that has led to the interpretation that State and local expenditures for higher education represent a transfer of public funds from the relatively less to the relatively more affluent members of society;[6] higher education thus competes for priority with many other public programs, notably highways and social security.

PHILANTHROPY

Income from philanthropic sources (included in "Other" in Table 3-1) has also declined in relative importance, and by an amount that is comparable to that from State and local governments. Although large increases in institutional income have been provided by the management of endowments and by gifts and grants from individuals, business corporations, foundations, and other philanthropic organizations, this source of income has not been able to keep pace with the expenditures of institutions for educational and general purposes, quite apart from expenditures specifically for graduate education.[7] An analysis

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[6] *Ibid.*, p. xxix, Item 88, and Chapter 24, pp. 325 ff.

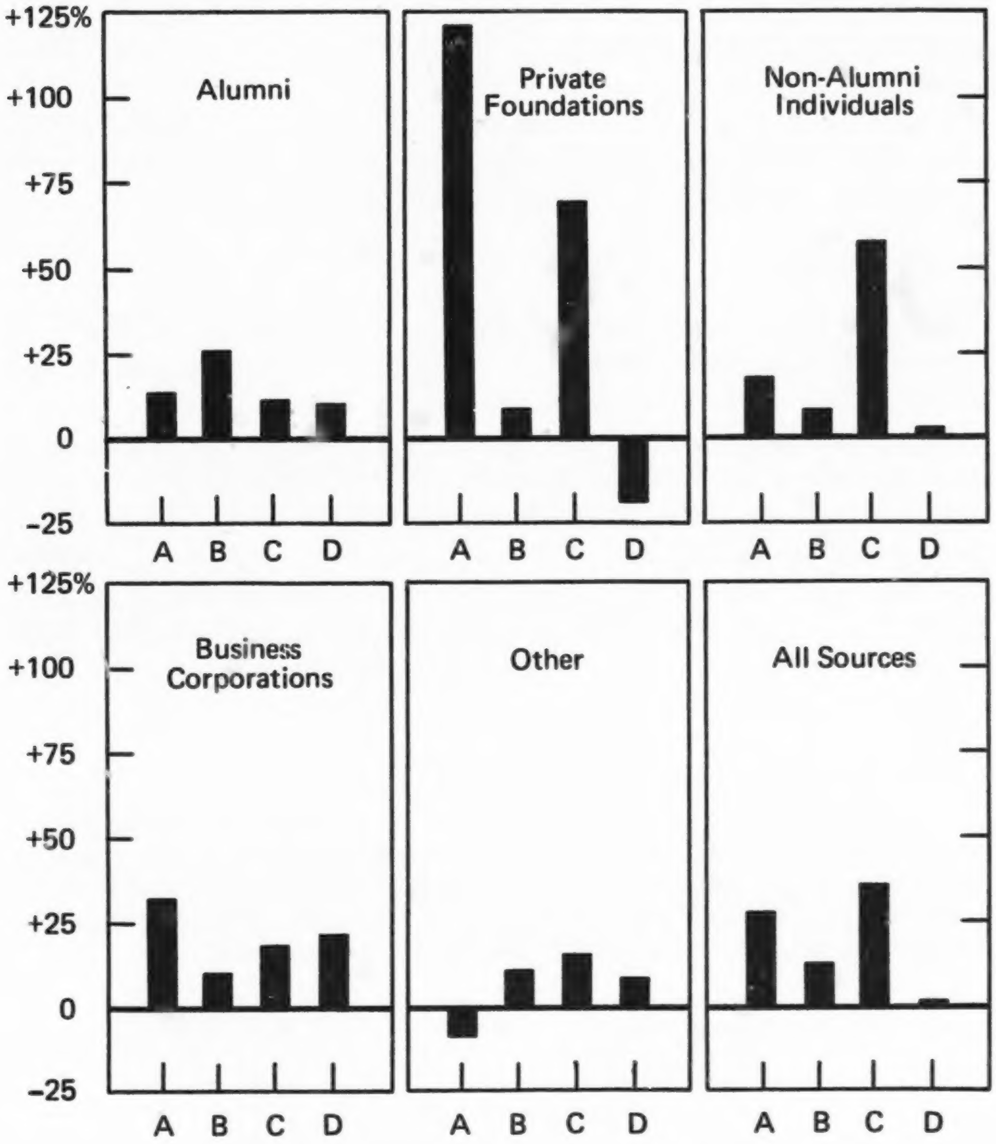
[7] It is also important to note the variety of purposes for which philanthropic gifts have been made. The following distribution has been reported, for total gifts to colleges and universities for academic years 1954-1955 to 1966-1967 inclusive, in *Voluntary Support of Education, 1966-1967*, American Alumni Council and Council for Financial Aid to Education:

Unrestricted	30.1%
Physical Plant	24.9
Basic Research	12.7
Student Financial Aid	11.9
Faculty Compensation	8.5
Other	11.9

This distribution has been relatively stable over the time period reported. However, a large percentage of these gifts and bequests is identified with capital funds. This percentage has been estimated by the John Price Jones Company, *American Philanthropy for Higher Education, A Report for 1965-*

Figure 3-1

BIENNIAL PERCENTAGE CHANGES IN PHILANTHROPIC CONTRIBUTIONS TO HIGHER EDUCATION



A=1958-59 to 1960-61 C= 1962-63 to 1964-65
B=1960-61 to 1962-63 D=1964-65 to 1966-67

Sources: *Voluntary Support of Education 1966-1967* and previous Years, American Alumni Council and Council for Financial Aid to Education of the rate of growth of income from philanthropic sources for a recent period is shown in Figure 3-1. Of major significance is the decision of certain of the largest foundations in recent years to divert grants from the direct support of higher education to an attack on major problems of society. There remains, however, an unresolved question of the extent to which business corporations can be expected to contribute, especially to graduate education, although they have recently formed the fastest growing segment of such philanthropy, and of the tax and other financial incentives that should be developed to encourage them to do so.

FEDERAL RESEARCH

Income from Federal research funding remains the sole major source of institutional income that has consistently demonstrated a relative increase, over the time scale considered, in its contribution to the educational and general purposes of the university. Although the amount of such Federal funding may be partially distorted by the occasional inclusion in biennial reporting of support for Federal Contract Research Centers (See Footnote 3), it is clear that the trend is in the direction of an ever-increasing Federal role in the support of higher education through this mechanism. Federal research funding has become the largest single source of income for 58 privately controlled universities, the second largest for 88 publicly controlled universities. Federal research funding thus assumes an important and controlling position with respect to university income. The effect of this control can be demonstrated as follows (See Table 3-2 for sources of current-fund income for educational and general purposes for these 146 universities in academic year 1963-1964): Assume that each of the major sources of income of the **combined** group of 146 universities is changed, in turn, by 20 percent; the resulting percentage changes in total income can then be computed:

66, *Gifts and Bequests to Fifty Selected Colleges and Universities*, to be 70.7 percent on the basis of the survey for the 1965-66 academic year. A similar percentage can be derived from the biennial reports on financial statistics of the Office of Education (DHEW).

Table 3-2

SOURCES OF CURRENT-FUND INCOME FOR EDUCATIONAL AND GENERAL PURPOSES

1963-1964

(dollars in thousands)

	PUBLIC UNIVERSITIES (1)		PRIVATE UNIVERSITIES (1)	
Tuition and Fees . .		$ 368,800		$ 495,806
Federal funds.				
Land-grant Insts.	$ 114,308		$ 3,663	
Research	720,726		587,901	
Other (2)	79,472		57,825	
Total		914,506		649,389
State Funds.				
Federal (3)	49,806		551	
State Appro. . . .	1,305,344		44,730	
Total		1,355,149		45,282
Local Gov.		40,892		8,090
Endowment (4) . . .		25,499		126,143
Private gifts (5) . . .				
Alumni	5,227		17,384	
Services (6)	135		4,685	
Churches	62		14,585	
Corporations. . .	26,657		22,671	
Foundations . . .	37,899		47,369	
Non-alumni . . .	8,610		15,169	
Other	25,843		47,897	
Total		104,432		169,760
Other (7).		270,974		174,888
Total		$3,080,254		$1,669,357

(1) Includes 88 publicly and 58 privately controlled institutions.

(2) Includes tuition and fees paid directly to institutions.

(3) Federal funds, other than land-grant funds, received through State channels.

(4) Amounts applicable to current educational and general expenditures; includes earnings from land-grant funds.

(5) Amounts applicable to current educational and general expenditures.

(6) Estimated monetary value of non-salaried or contributed services.

(7) Includes gross income (sales, services, etc.) associated with educational departments, libraries, medical school hospitals, etc.

Source: Office of Education (DHEW). Details do not add to totals because of rounding.

Source of Funding	Effect on Total Income of 20% Change in Source of Funding
State appropriations	5.7%
Federal research	5.5
Student fees	3.6
Private gifts	1.2
Endowment	0.6

If, following an estimate to be developed later, graduate education in this group of universities represents about 66 percent of the total income for educational and general purposes, a 20 percent change in Federal research funding corresponds to an institutional change of 8.4 percent in total income for graduate education. If Federal research funding is associated only with income for graduate education in the sciences and engineering, the corresponding change in income for this part of graduate education becomes even greater.

EXPENDITURE RELATIONSHIPS

The gross pattern of expenditures for this same group of universities is illustrated in Table 3-3 for current-fund expenditures for educational and general purposes. As in the case of current-fund income, expenditures for Auxiliary Enterprises have been omitted. There are three trends of special interest:

ADMINISTRATIVE AND GENERAL EXPENDITURES

Administrative and general expenditures have remained relatively constant as a fraction of total expenditures. In view of the other trends discussed below, this trend appears to reflect increased administrative requirements associated with relatively increasing Organized Research. Further, both publicly and privately controlled universities appear to be approaching a common value of about 10 percent of expenditures for educational and general purposes devoted to this classification. This figure, however, should not be confused with the "indirect costs" negotiated in connection with Federal grants and contracts, since expenditures for many items, such as the operation and maintenance of libraries and the physical plant, are not included.

Table 3-3

EXPENDITURE RELATIONSHIPS

Distribution of Current-Fund Expenditures for Educational and General Purposes

PUBLIC UNIVERSITIES (1)

Year	Total (millions)	Admin. and Gen.	Inst. & Dept. Res.	Organized Research (2)	Other (3)
1951-52	704	8.1%	37.4%	22.1%	32.4%
1953-54	849	8.0	37.4	21.8	32.8
1955-56	1127	7.7	35.7	23.5	33.1
1957-58	1469	8.5	34.7	26.0	30.8
1959-60	1805	8.3	33.8	28.1	29.8
1961-62	2300	8.1	33.1	30.8	28.0
1963-64	2958	8.8	33.2	30.4	27.6

PRIVATE UNIVERSITIES (1)

Year	Total (millions)	Admin. and Gen.	Inst. & Dept. Res.	Organized Research (2)	Other (3)
1951-52	457	11.8%	39.9%	23.2%	25.1%
1953-54	506	12.9	39.5	23.2	24.4
1955-56	601	13.2	37.3	26.3	23.2
1957-58	754	13.0	36.5	29.1	21.4
1959-60	979	11.7	33.7	34.8	19.8
1961-62	1262	11.5	32.4	36.4	19.7
1963-64	1581	11.0	31.8	37.9	19.3

(1) Includes 88 publicly and 58 privately controlled institutions.
(2) Includes direct expenditures only.
(3) Includes extension and public services, libraries, operation and maintenance of the physical plant, etc.

Source: Derived from data made available by the Office of Education (DHEW).

INSTRUCTION AND DEPARTMENTAL RESEARCH

Over the 12-year period represented in Table 3-3 expenditures for Instruction and Departmental Research have declined steadily in both publicly and privately controlled universities as a fraction of total expenditures. This situation continues a trend that has prevailed at least since 1930.[8] It is of interest to note that the category "Other," which includes such operating expenditures as those for libraries and the physical plant, has also experienced a relative decline during the period 1951-1952 to 1963-1964, and by percentages that are comparable to those for Instruction and Departmental Research. At the same time, the two types of expenditures (Instruction and Departmental Research and "Other"), considered together, have increased in absolute dollar amount during this time period by about 231 percent, an increase that can roughly be accounted for by combining the percentage increase of resident enrollment in higher education and an annual percentage increase for price inflation, of the order of five (5) percent, for faculty salaries and other elements of institutional operations that have increased faster than such measures as the Consumer Price Index.

It is important to observe that, while the accounting classification of Instruction and Departmental Research implies the conduct of unsponsored research by members of departmental faculties, there is no available information regarding trends within this classification in available funds for the acquisition of supplies and equipment and other expenditures normally associated with research activity. It is commonly believed that such funds for research support have disappeared in private universities and are low in publicly controlled universities. If this classification consists at the present time largely of salaries, it would confirm the percentage increase, noted above, that can be accounted for by increases in enrollment (number of faculty) and price inflation (faculty salaries).

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[8] It has been reported by John D. Millett, *Financing Higher Education in the United States*, New York, Columbia University Press, 1952, prepared for the Commission on Financing Higher Education under the sponsorship of the Association of American Universities, p. 107, that expenditures for "Departmental instruction and research" declined from 63.0 percent of educational and general expenditures in all institutions of higher education in 1930 to 53.1 percent in 1940 and to 45.1 percent in 1950. These figures are generally consistent with those of Table 3-3 for 146 universities in 1951-1952.

ORGANIZED RESEARCH

The term "Organized Research" is discussed later in this chapter. It was introduced during the 1930's and is generally defined as research that is "separately budgeted and accounted for." As such, it consists largely, although not necessarily, of "Sponsored Research" supported by Federal, State and local, industrial, or other sources, a term that is replacing the older expression.

It is seen in Table 3-3 that Organized Research, sponsored by the Federal Government, by State and local governments, or by private organizations, has increased dramatically over the time period considered, for both publicly and privately controlled universities, as a fraction of the whole.[9] That Organized Research may be interpreted by some as an "overlay" on the traditional academic process of instruction, scholarship, and research is suggested in Table 3-4. It is seen that Instruction and Departmental Research bears an almost constant relationship to both non-Federal income and to expenditures for "Other than Organized Research." Conversely, Instruction and Departmental Research has declined continuously relative to Organized Research, while the fraction of Organized Research accounted for by Federal funding has grown.

It should further be noted that publicly and privately controlled universities exhibit different patterns with respect to the sponsors of Organized Research. For academic year 1963-1964 the *direct* expenditures for Organized Research are distributed as follows (See Table 3-5 and Footnote 3):

	Public Universities	Private Universities
Federal	72.0%	86.5%
Private Organizations	5.9	8.9
State and local	12.0	1.8
Other	10.0	2.8
	99.9	100.0

The public universities appear to be better able to exploit opportunities for interaction with the community, while the pri-

Table 3-4

RATIOS OF INSTRUCTION AND DEPARTMENTAL RESEARCH AND FEDERAL RESEARCH TO NON-FEDERAL INCOME AND ORGANIZED RESEARCH

Year	I + DR/NF	I + DR/NO	I + DR/OR	FR/OR
(PUBLIC UNIVERSITIES)				
1951-52	0.450	0.480	1.691	---
1953-54	0.442	0.477	1.717	0.586
1955-56	0.430	0.466	1.520	0.553
1957-58	0.430	0.469	1.338	0.593
1959-60	0.434	0.470	1.205	0.691
1961-62	0.442	0.480	1.081	0.740
1963-64	0.453	0.476	1.092	0.802
(PRIVATE UNIVERSITIES)				
1951-52	0.533	0.520	1.725	---
1953-54	0.510	0.514	1.695	0.925
1955-56	0.467	0.507	1.417	0.823
1957-58	0.455	0.516	1.257	0.838
1959-60	0.470	0.517	0.967	0.894
1961-62	0.472	0.510	0.891	0.945
1963-64	0.493	0.513	0.839	0.981

Abbreviations:

I + DR. . . . Current-Fund Expenditures for Instruction and Departmental Research

NF. . . . . . . Non-Federal Current-Fund Income

FR. . . . . . . Current-Fund Income-Federal Research

OR. . . . . . Current-Fund Direct Expenditures for Organized Research

NO. . . . . . . Current-Fund Expenditures for Other than Organized Research

Source: Computed from data made available by the Office of Education (DHEW).

Table 3-5

DISTRIBUTION OF CURRENT-FUND EXPENDITURES FOR EDUCATIONAL AND GENERAL PURPOSES

1963-1964

(dollars in thousands)

	PUBLIC UNIVERSITIES (1)		PRIVATE UNIVERSITIES (1)	
Administration and General		$ 262,707		$ 173,260
Instruction and Departmental Research		981,143		503,233
Extension and Public Service		256,734		12,728
Libraries		80,868		47,560
Plant Operation and Maintenance		218,944		118,335
Organized Research-Federal (2)				
OE	$ 7,361		$ 4,785	
NIH	142,470		176,187	
DHEW - Other	4,081		6,617	
AEC	279,760		127,780	
DOD	78,560		126,398	
NASA	17,444		15,030	
NSF	53,748		40,790	
Other	63,923		21,079	
Total		647,347		518,665
Organized Research - Other (2)				
Private	53,456		53,248	
State and Local	108,071		10,823	
Other	89,648		16,902	
Total		251,175		80,973
Other (3)		259,444		126,332
Total		$2,958,362		$1,581,087

(1) Includes 88 publicly and 58 privately controlled institutions.
(2) Includes direct expenditures only.
(3) Does not include expenditures for auxiliary enterprises or student-aid expenditures for scholarships, fellowships, and prizes.

Source: Office of Education (DHEW). Details do not add to totals because of rounding.

Table 3-6

INCOME FOR THE PHYSICAL PLANT

1963-1964

(dollars in thousands)

	PUBLIC UNIVERSITIES (1)		PRIVATE UNIVERSITIES (1)	
Federal				
OE	$ 981		$ 12	
NIH	27,611		10,511	
DHEW - Other	3,969		674	
AEC	3,050		2,694	
DOD	104		202	
NASA	1,826		2,102	
NSF	15,173		10,252	
Other	3,949		93	
Total		$ 56,662		$ 26,541
State and Local		349,827		1,352
Private Sources		27,579		93,624
Transfers (2)		151,623		90,780
Loans				
Federal	49,641		42,844	
Other	247,937		101,757	
Total		297,578		144,601
Other (3)		67,266		13,365
Total (4)		$950,535		$370,263

(1) Includes 88 publicly and 58 privately controlled institutions.
(2) Includes transfers from current funds.
(3) Includes earnings on plant-fund investments and proceeds from sale of plant-fund assets.
(4) Total income during the year applicable to Unexpended Plant Funds and Funds for the Retirement of Indebtedness.

Source: Office of Education (DHEW). Details do not add to totals because of rounding.

vate universities are more vulnerable to variations in Federal appropriations, although there are additional factors that contribute to these patterns and vitiate simple interpretations.

PHYSICAL PLANT FUNDING

The pattern of income received by this same group of 146 universities in academic year 1963-1964, for use either in building new physical plant or in reducing outstanding loans previously incurred in connection with the physical plant, is shown in Table 3-6. The largest single item is income received by public universities from State and local sources. It may be observed that the Federal total for that year, principally received from the National Institutes of Health and the National Science Foundation, amounted to 9.5 percent of all such income, other than loans, for the two groups of universities combined, while the Federal Government contributed 20.9 percent of all loans made for this purpose. These figures will be seen in perspective below.

SUPPORT OF GRADUATE STUDENTS

A summary of the sources of support of 124,255 full-time graduate students in science and engineering at 204 doctoral institutions, reported in the Fall of 1966, is shown in Table 3-7. The details of this pattern have been fully analyzed in a recent publication.[10]

Several features are of interest. The largest single group, approximately one-half of the total, of this class of graduate students is supported by sources, including the educational institutions themselves, other than those identified in the table.

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[9] John D. Millett, *op. cit.*, p. 107. The corresponding figures for Organized Research in 1930, 1940, and 1950 were 5.3 percent, 5.6 percent, and 14.2 percent, respectively, for all institutions of higher education. The last figure is comparable with 22.1 percent and 23.2 percent, respectively, in public and private universities in 1951-1952 (See Table 3-3). For the earlier years Organized Research consisted largely of support for the agricultural experiment stations.

[10] *Graduate Student Support and Manpower Resources in Graduate Science Education*, Publication No. NSF 68-13, Washington, National Science Foundation, June 1968.

Table 3-7

SUPPORT OF GRADUATE STUDENTS

Numbers of Full-Time Graduate Students Supported
in Science and Engineering

Distribution by Source and Type of Support (1)

Fall 1966

	Fellow-ships	Trainee-ships	Research Assist.	Teaching Assist.	Other	Total
AEC	343	105	2,040	2	45	2,535
NASA.	729	2,815	1,150	7	92	4,793
NDEA.	5,583	421	34	11	32	6,081
PHS.	2,569	4,709	2,564	48	109	9,999
NSF	2,766	4,057	3,812	41	322	10,998
VA	51	416	39	-	172	678
Other.	1,297	724	6,345	213	2,062	10,641
Total Federal . .	13,338	13,247	15,984	322	2,834	45,725
State and Local .	240	179	1,251	1,322	575	3,567
Foundations . . .	1,991	79	746	37	321	3,174
Industry.	1,579	29	944	40	1,092	3,684
Foreign Sources	1,301	65	92	16	3,061	4,535
Other.	5,294	276	8,182	26,749	23,069	63,570
Total	23,743	13,875	27,199	28,486	30,952	124,255

(1) Data covers 103,386 U. S. citizens and 20,869 foreign students in 2,866 departments in 204 doctorate-granting institutions. The Federal Total includes 41,209 U. S. citizens and 4,516 foreign students.

Source: National Science Foundation, Graduate Traineeship Program

Nearly 20 percent of the total, 23,069 students, are self-supported, supported by loans, etc. About one-third of the total is supported by the Federal Government. Of those receiving Federal support the largest number are supported through research assistantships, largely through grants and contracts for research.

Although the support of graduate students in science and engineering in the Fall of 1966 cannot, strictly speaking, be compared with fiscal patterns of academic year 1963-1964, a general overview of the extent of Federal involvement is nevertheless of interest. The following percentages may be regarded as providing a rough indication:

1. Federal research support, considered as a percentage of the **total** current-fund income for educational and general purposes of 146 universities 27.6%
2. The number of full-time graduate students in **science and engineering** (approximately one-third of the total) receiving Federal support ... 36.7%
3. The Federal contribution to the **total** income for the physical plant of 146 universities, including both grants and loans 13.3%

Since Federal research support constitutes a considerably larger fraction of support for graduate education than it does of **total** current-fund income of universities, while being specifically associated with science and engineering, it is clear that the pattern of Federal support of **graduate education** as a whole is quite uneven. This circumstance raises the all-important question of the Federal intent in supporting research in universities, vital as it has been to the growth and success of science in the United States, as well as the Federal role in relation to graduate education and the mechanisms that are appropriate to exercising this role. This question will be considered in the following two sections.

RESEARCH, INSTRUCTION, AND GRADUATE EDUCATION

The first overt support by the Federal Government of research in or in association with educational institutions appears to have occurred in 1887 with the passage of the Hatch Act,[11] a measure that provided for the establishment of the agricultural experiment stations through the award of $15,000 annually to each of the States for use by the land-grant colleges "... to promote scientific investigation and experiment respecting both principles and applications of agricultural sciences . . ." This legislation resulted largely from advocacy by the land-grant colleges themselves, who recognized the importance of research in support of their mission to society and who were aware of their accomplishments "in the direction of scientific training and investigation."[12] Thus began a dialogue between the universities and the Federal Government that has continued to the present. Through deficiencies of the English language a semantic gap was opened and has persisted. For the universities the "scientific training and investigation" of the 1880's has become the "graduate education and academic research" of the 1960's, an expression that appears even in the first report of the National Science Board; for the Federal Government the "scientific investigation and experiment" of the 1880's has become the "research and development" of the 1960's. This communicational barrier has not been complete; there have indeed been many in the Congress and the Executive Branch who have understood that research is an essential part of the environment within which graduate education flourishes, while many in the universities have certainly sought the funds for the conduct of research *qua* research. But the central problem has remained: research, for limited periods of time, can thrive without graduate education; graduate education cannot thrive without research. In the 1880's doctoral education was still a new departure in the United States. At the same time, there was a growing consciousness of the potential that science possessed for contributing to the solution of the multiplying problems of a rapidly expanding Nation. The Federal Government, ever confronted by these problems, sought the short-term solution in the public interest. The universities, ever confronted by difficult financial requirements, have increasingly sought to contrive a long-term solution from a patchwork of short-term ingredients — also in the public interest.

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[11] 24 Stat. 440, March 2, 1887.

[12] For a discussion of this development, see A. Hunter Dupree, *Science in the Federal Government*, Cambridge, Mass., Harvard University Press, 1957, pp. 169 ff.

World War I witnessed the formal establishment of mechanisms for harnessing the Nation's resources for scientific research. With the formation of the National Research Council, ". . . whose purpose shall be to bring into cooperation existing governmental, educational, industrial, and other research organizations . . . ," [13] the basis was laid for a dual role of the university as an educational center and as a source of short-term research capability. Scientists were recruited into the defense effort on a major scale. The implications, however, were serious, for

> in setting up the machinery to accomplish these [recent scientific wartime] achievements we at the same time set up the machinery for the destruction of advances beyond a certain point. . . . While I am not in a position to know the exact situation elsewhere in the world, I do know that we in the United States had early in the summer of 1918 arrived at the state where scientific man-producing machinery no longer existed.[14]

During the years following World War I increasing emphasis was placed on the need to support basic scientific research in the universities, but as an activity separate and distinct from the educational process. Both recognition of an urgent problem of society and misunderstanding of the role of research in the university were summarized in 1927:

> Some months ago our leading scientists in reviewing the organizations of pure science of the country were discouraged to find that their activities had been actually

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[13] *Ibid.*, pp. 309 ff.

[14] *Ibid.*, p. 324. A quotation from Frank B. Jewett.

> diminished during the last decade, whereas if these laboratories are to furnish the increasing vital stream of discovery to our nation, and our normal part to the world, they should have been greatly enlarged. . . . Our universities have doubled in the number of their students. Their pre-war endowments and income have been depreciated by the falling dollar. New resources have been given many of them, but not enough to handle their new burdens of teaching. . . . Teaching is a noble occupation, but other men can teach and few men have that quality of mind which can successfully explore the unknown in nature . . . our universities [are] compelled to curtail the resources they should contribute in men and equipment for this patient groping for the sources of fundamental truth because of our educational pressures . . . the obvious function of education is to organize and transmit our stock of knowledge—it is not primarily concerned with the extension of the borders of knowledge EXCEPT SO FAR AS THE PROCESS IS EDUCATIONAL *(emphasis added)* . . . [15]

The opportunity was there to propound a better solution, but it was lost and the watchword became "support of scientific research."

World War II provided a repetition, on a vastly increased scale, of the World War I experience. The termination of hostilities, however, led to the institutionalization of Federal involvement in academic science. Two parallel lines of development emerged, both deriving from the wartime Office of Scientific Research and Development (OSRD):

1. Public recognition of the important part that had been played by science in support of the military establishment led first to legislation that formed the Office of Naval Research,[16] and subsequently to a rapidly growing body of legislation to authorize and appropriate funds to many Federal agencies to undertake research

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[15] Herbert Hoover (Secretary of Commerce), *The Nation and Science*, Science, Vol. LXV, No. 1672, pp. 26 ff., January 14, 1927.

[16] 60 Stat. 780, August 1, 1946.

and development in support of their missions and to sponsor such activity in universities and elsewhere. This process, however, although it has become the major source of support for graduate education in the United States, has had the purpose of utilizing the scientific and engineering resources of the Nation in the public interest. The universities have not occupied an unique position. Characteristically, the Office of Naval Research was authorized to use sums appropriated "to pay the cost of . . . research and development work under contracts with individuals, corporations, and educational or scientific institutions." [17]

2. Almost simultaneously, in 1945, a report was submitted to the President in response to specific questions concerning, among other matters, programs for "discovering and developing scientific talent in American youth so that the continuing future of scientific research in this country may be assured on a level comparable to what has been done during the war." [18] The report contained recommendations for the formation of a new agency "devoted to the support of scientific research and advanced scientific education alone." The subsequent establishment of the National Science Foundation [19] marked the first formal recognition that the Federal Government had a role in strengthening science and science education in America's colleges and universities. Again, however, quite apart from the statutory separation of the sciences from the arts and humanities, the linguistic dichotomy of "science" and "science education" persisted. The resulting program of research project grants of the Foundation has been largely indistinguishable from similar programs in other agencies whose missions have required the input of new scientific knowledge, while the Foundation program for the

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[17] 10 U.S.C. 5152.

[18] Vannevar Bush, *SCIENCE The Endless Frontier*, Washington, United States Government Printing Office, July 1945, pp. vii, viii, 26.

[19] 64 Stat. 149 (Public Law 507 of the 81st Congress).

> support and strengthening of science education, even at the graduate level, has remained separate. However, although the programs of the Foundation and other agencies may be formally identical with respect to procurement practice, there appears to be a fundamental difference between the two in the matter of intent, namely, the difference between support of the academic endeavor and interest in obtaining research results of benefit to agency missions.

There has been public discussion of the problem addressed here. For example, in 1960: [20]

> Graduate education for scientists is usually seen as what comes after the B.A. and before the Ph.D. For us it is this, but also more, and in our view any definition in terms of an interval between two degrees obscures much more than it clarifies. We are using the term here to mean that part of education which seeks to turn a young man or woman into a scientist. By the word "scientist" we mean someone who is fit to take part in basic research, to learn without a teacher, to discover and attack significant problems not yet solved, to show the nature of this process to others—someone, in short, who is equipped to spend a lifetime in the advancement of science, to the best of his ability. It is a fundamental contention of this report that the process of graduate education and the process of basic research BELONG TOGETHER at every possible level. We believe that the two kinds of activity reinforce each other in a great variety of ways, and that each is weakened when carried on without the other. We think also that this proposition has substantial implications for the policy of both the Federal Government and the universities.

and:

> But if all this is so, it does not seem to be fully recognized in the standard practices of most universities and

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[20] President's Science Advisory Committee, *Scientific Progress, The Universities, and The Federal Government*, Washington, U.S. Government Printing Office, 1960, pp. 4-5.

> Federal agencies. For as we are describing it, the process of graduate education depends on "research" just as much as upon "teaching"—indeed the two are essentially inseparable—and there is a radical error in trying to think of them as different or opposite forms of activity. From the point of view of the graduate student, the teaching and the research of his professor are, at the crucial point which defines the whole, united. What he learns is not opposite from research; it IS research.

That the subject has remained one of confusion is illustrated by the following excerpts, all taken from the **same** report prepared by the Bureau of the Budget:[21]

> Colleges and universities have a long tradition in basic research. The processes of graduate education and basic research have long been closely associated, and reinforce each other in many ways. This unique intellectual environment has proven to be highly conducive to successful undirected and creative research by highly skilled specialists. Such research is not amenable to management control by adherence to firm schedules, well-defined objectives, or predetermined methods of work.

and:

> Often there is a tendency to believe that in providing support for a single specific project the chance of finding a solution to a problem is being maximized. In reality, however, less specific support often would permit more effective research in broad areas of science, or in interdisciplinary fields, and provide greater freedom in drawing in more scientists to participate in the work that is undertaken. Universities, too, often find project support cumbersome and awkward. A particular professor may be working on several projects financed by several

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[21] U.S. Congress. Senate. Committee on Government Operations. Report to the President on Government Contracting for Research and Development. Document No. 94. 87th Congress, 2d Session. Washington, U.S. Government Printing Office, 1962, pp. 10, 11, 18.

> Government agencies and must make arbitrary decisions in allocating expenses to a particular project. It thus appears both possible and desirable to move in the direction of using grants to support broader programs, or to support the more general activities of an institution, rather than to tie each allocation of funds to a specific project.

but:

> . . . we consider it necessary and desirable to use a variety of arrangements to obtain the scientific and technical services needed to accomplish public purposes. Such arrangements include: direct governmental operations through laboratories or other installations; operation of Government-owned facilities by contractors; grants and contracts with universities and entities associated with universities; contracts with not-for-profit corporations wholly or largely devoted to performing work for Government; and contracts with private business corporations. . . . Choices among available arrangements should be based primarily on two factors:
>
> Relative effectiveness and efficiency, and
> Avoidance of conflicts of interest.

There has been a parallel, continuing, but initially independent development in the financial procedures of universities.[22] In 1935 the National Committee on Standard Reports for Institutions of Higher Education, appointed in 1930 by the U.S. Office of Education, issued a report containing recommendations concerning financial reports of colleges and universities.[23] One of its recommendations involved the use of the category "Organized Research" for standard reporting purposes.

This term has been interpreted as one that simply recognized the growth and evolution of cooperative research ventures beyond the traditional, individualistic activities of single scholars. ". . . individual scholars within universities began to band together in more or less formally organized units to carry on joint research. Other scholars set up research projects requiring numerous associates and assistants to execute."[24] In 1935, as noted previously, such activities amounted to little more than 5 percent of current-fund expenditures for educational and general purposes, principally related to the operation of the agricultural experiment stations.

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[22] For a discussion of this history, see John Dale Russell, *op. cit.*, pp. 39 ff.

[23] National Committee on Standard Reports for Institutions of Higher Education, *Financial Reports for Colleges and Universities*, Chicago, University of Chicago Press, 1935.

Following World War II efforts, participated in jointly by representatives of the universities and the Federal Government, were made to establish the principles under which reimbursement would be made to educational institutions for the conduct of research and development. In the most recent statement of these principles there are four definitions that are relevant to the present discussion:[25]

> ORGANIZED RESEARCH means all research activities of an institution that are separately budgeted and accounted for.
>
> DEPARTMENTAL RESEARCH means research activities that are not separately budgeted and accounted for. Such research work, which includes all research activities not encompassed under the term *organized research,* is regarded for purposes of this document as a part of the instructional activities of the institution.
>
> APPORTIONMENT means the process by which the indirect costs of the institution are assigned as between (a) instruction and research, and (b) other institutional activities.
>
> ALLOCATION means the process by which the indirect costs apportioned to instruction and research are as-

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[24] John D. Millett, *op. cit.*, pp. 24 ff.

[25] Bureau of the Budget, *Principles for Determining Costs Applicable to Research and Development Under Grants and Contracts with Educational Institutions*, Circular No. A-21 (Revised), Executive Office of the President, March 3, 1965, p. 2.

> signed as between (a) organized research, and (b) instruction, including departmental research.

The implications of these definitions appear to be (a) that research (i.e., departmental research) and instruction are indeed interrelated in the educational process, and (b) that organized research (i.e., research supported by the Federal Government) is not so related. Although these definitions may not directly alter arrangements for the actual research operations within a university, they clearly betray a continuing sense that the support of academic research by the Federal Government is somehow different from the support of graduate education.

It is of interest to note that the most recent statement of principles of business administration by the academic community[26] discontinues use of the term "organized research" in favor of:

> SPONSORED RESEARCH. Research activities performed in accordance with the conditions of agreements with governmental agencies or other outside organizations or persons to conduct research of specified scope.

The term "departmental research" in the previous sense is, however, retained.

On the other hand, impressive confirmation of the identity of academic research and graduate education is found in a **linear relationship** prevailing between the number of doctorates awarded by universities in science and engineering and the amount of Federal funds received for the support of research, a relationship with a correlation coefficient of 0.85.[27]

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[26] American Council on Education, *College and University Business Administration*, Revised Edition, Washington, 1968, p. 282.

[27] William V. Consolazio, *The Dynamics of Academic Science*, Publication No. NSF 67-6, Washington, National Science Foundation, January 1967, pp. 61 ff.

ACADEMIC ACCOUNTING AND THE FEDERAL GOVERNMENT

The distinction between the academic institution and the industrial organization is nowhere better illustrated than in the treatment of cost. The industrial organization, in selling a product, **must** recover the cost of the product before it can make a profit; it must, therefore, know what the cost is, before it can safely establish a price in a competitive market. The result has been the development of elaborate systems of cost accounting, designed to identify and classify **all** types of cost, and to provide for their reasonable allocation to the items to be sold.

Typically, these cost categories include: direct costs (generally labor and materials), indirect costs or overhead (items, such as heat, light, and power, depreciation of fixed assets, and supervision, that cannot reasonably be identified with individual units of production, especially for complex and multiple product lines, and that are generally allocated as a percentage of direct cost), and general and administrative expense (generally allocated, especially in multi-departmental organizations, as a percentage of manufacturing cost, composed of the direct and indirect costs above). The resulting "cost" is useful to industry for price setting, budgeting, managerial control of operations, and efforts to reduce cost in order to improve competitive position.

Three types of organizations, characteristically, do **not** attempt to determine cost in the sense outlined above: academic institutions, the family, and the Federal Government. There are others. The products, services, and activities of these organizations are too varied and too little purpose would, in general, be served to require the procedures of full cost analysis. Instead, these organizations manage their operations through the budgeting and control of **funds.** Each fund is identified with a class of activities or programs; money is spent from the fund and it is ultimately depleted or replenished. Expenditure of money from a fund is thus treated essentially as a direct cost.

In the family each fund is earmarked, formally or informally, with some aspect of family life (e.g., food, rent, insurance, etc.). In the Federal Government each fund is established by authorizing legislation and money is made available to the fund by appropriation. In the academic institution funds may be established by the donor as **restricted** funds, or, if the contribution is **unrestricted,** by the institution in accordance with its needs and activities. The characteristic grant-in-aid to an academic institution by a private foundation for an identified research project is generally of the former type; the revenue from an endowment or an alumni fund is generally at the free disposal of the institution.[28]

When the Federal Government wishes to procure research and development service from an industrial organization, the costs of this contract service are negotiated on the basis of industrial cost accounting practice (as applied by the particular firm in question, with the exception of certain costs that are disallowed in the public interest and that the firm must recover elsewhere). Thereafter a fee or profit is negotiated. A difficulty arose, however, when the Government, at the end of World War II, wished to continue to procure research service from an educational institution, for its accounting practice, developed to reflect its characteristic type of operation, did not provide for a determination of cost. The problem had been obviated under the emergency of the War through the use of contracts with the universities which, in fact, resulted in many instances in surpluses being realized.[29] At the end of the War it was the military departments, with long experience in contracting with industry for research and development, that had the burden of developing the contracting and financial procedures for this new relationship with academic institutions. The principles of contracting and auditing, as applied to defense contractors, were not transferred indiscriminately to the universities; that differences existed was recognized and attempts were made to define the new relationship. This effort, however, took the form of a restatement of the procurement "cost principles" in a document widely known as *The Blue Book*.[30] It should be noted that this document was addressed more to differences in the allowability of **costs** than to the basic concepts that underlie the Government-university relationship. **In effect, therefore, the academic institution was required to do business with the Government in accordance with the principles of cost accounting.** This situation, with modifications, persists to the present.

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[28] It would be misleading to imply that academic institutions have not been concerned with the problems of unit-cost determination. Relevant procedures have been proposed and opposed with vigor since the 1930's. Directed as much to justifications to boards of trustees and State legislatures as to control of operations, such procedures frequently are concerned with computing the cost of a student credit-hour, and are thus centered on matters of undergraduate instruction. For a general discussion see Seymour E. Harris, *op. cit.*

[29] See John Dale Russell, *op. cit.*, p. 384.

During the 1950's, with additional Federal agencies undertaking the financing of research in academic institutions in support of their missions, the National Science Foundation recognized the need for a uniform statement of cost principles, suitable for Government-wide application. Following recommendations to the Bureau of the Budget, a working group was formed, consisting of representatives of all agencies that supported scientific research, and joined by representatives of univerisities. The outcome was Bureau of the Budget Circular No. A-21.[31] Like *The Blue Book* this document adopted the cost accounting framework, beginning with the definitions, noted in the preceding section, of "organized research" and "departmental research" and the allocation of indirect costs to "organized research" and "instruction, including departmental research." This set of cost principles was revised, partly in response to recommendations of a Special Committee on Sponsored Research of the American Council on Education, on January 7, 1961, and again on March 3, 1965.

There are three aspects of the application of these cost principles that illustrate the artificialities involved, especially as they relate to graduate education.

1. From the beginning of this sequence, an important step has been the determination of "direct labor." This re-

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[30] *Explanation of Principles for Determination of Costs under Government Research and Development Contracts with Educational Institutions*, War Department—Navy Department, August 1947.

[31] *Principles for Costing Research and Development Under Grants and Contracts with Educational Institutions*, Circular No. A-21, Washington, Bureau of the Budget, September 10, 1958.

quirement, necessary for the implementation of a cost system, led to the controversial "time and effort reporting" practice when it involved members of the faculty working for part of their time on research projects. The issue has been that the time of the faculty member is not restricted to a 40-hour week, and is distributed over many activities, such as graduate and undergraduate teaching, research, and involvement in many academic, professional, and community affairs. The paradox has been that, in fact, the faculty member is the analogue of supervisory and managerial personnel in industry, treated as an **indirect cost,** while, on the other hand, if faculty were treated as indirect labor, there would be, in many instances, little or no direct cost base for the allocation of indirect costs. Debated for many years and relaxed in a series of revisions, the requirement for time and effort reporting was finally eliminated in 1968, in favor of a stipulated amount of salary, negotiated in advance, and representing a judgment of the "monetary value of the contribution which the individual is expected to make to the research project."[32] Although this represents a compromise of the paradox, the basic concept has not been changed, for the "amounts stipulated for salary support . . . . will be treated as direct costs."

2. As noted above, the notion of "indirect cost" is alien to academic financial practice (other than for the operation of auxiliary enterprises, such as dormitories and dining rooms, where a product or service is being sold). Again there has been controversy concerning the amount of indirect cost to be allowed, an issue that does not arise in the industrial counterpart. After various changes in limitation, it was determined, for example, in the Independent Offices Appropriations Act for Fiscal Year 1966, that the limitation should be eliminated, with the proviso that the Government may not reimburse the recipient of a grant for the full costs of a research project. As seen below, even without

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[32] Transmittal Memorandum No. 2, Circular No. A-21, Revised, Washington, Bureau of the Budget, June 1, 1968.

this restriction, application of Circular No. A-21 requires cost sharing, when compared with industrial allowances.

3. Comparison of Federal practice with respect to industry and educational institutions is most conveniently made by reference to the Armed Services Procurement Regulation (ASPR), where the corresponding cost principles are presented in juxtaposition as Parts 2 and 3 of Section 15. Specific allowances are generally parallel. However, the distinction made between "organized research" and other activities is frequently made the basis of a disallowance, since the costs involved "apply only to instruction and therefore are not allocable to research agreements" (terminology identical to that in Circular No. A-21). Among the costs disallowed are:

   a. Commencement and Convocation Costs (ASPR 15-309.5). However, costs of shareholders' meetings, etc., and the "incidental costs of directors and committee meetings" are allocable to industrial contracts (ASPR 15-205.24). ". . . committee or administrative work related to university business . . ." by faculty members may not be charged (ASPR 15-309.7).

   b. Costs of organized fund raising, endowment drives, etc., are disallowed (ASPR 15-309.16), but industrial selling costs are allowed (ASPR 15-205.37). Note that this provision is distinct from the allowability of "bidding" and "proposal" costs for industrial and academic organizations respectively.

   c. Costs of scholarships, fellowships, and other forms of student aid, costs incurred for intramural activities, student publications, etc., are disallowed on the grounds of being applicable "only to instruction" (ASPR 15-309.35, 309.40).

   d. Of special interest and also disallowed on the basis of being applicable "only to instruction" (ASPR 15-309.41) are the "costs of the deans of students, administration of student affairs, registrar, placement offices, student advisers, student health and infirmary services, . . . ," although an allocable portion of the costs of student services is allowed "... in the case of students actually engaged in work under research agreements ..." In short, only when a student is regarded as an employee, and hence direct labor on a grant or contract, may associated costs be recovered by the institution.

PROJECTION OF EXPENDITURES FOR GRADUATE EDUCATION

In view of the matters discussed above it is clearly impossible to compute with precision the cost of graduate education in the United States. However, because of the extreme importance of such cost, and its projection, to public policy for graduate education, it is necessary to form estimates, albeit rough, in order to gain an understanding of the magnitudes involved. Two estimates are attempted below.

EXPENDITURES FOR EDUCATIONAL AND GENERAL PURPOSES

In the absence of cost data that distinguish between graduate and undergraduate education, one recourse is to use estimates, necessarily a matter of informed judgment but no more, of the **relative** costs. Various estimates have been made and these estimates are reasonably consistent. For the purposes of the present report the following distribution has been chosen.[33] It relates to the cost of instruction, including salaries, supplies, and equipment. It is identified here with expenditures for Educational and General Purposes, other than Organized (i.e., Sponsored) Research. The value for the Lower Division, oriented toward the liberal arts, etc., is arbitrarily taken to be unity (1.00):

Level	Liberal arts, business, education, etc.	Science and Engineering
Freshman-Sophomore	1.00	1.54
Junior-Senior	1.67	2.75
Graduate	3.63	5.63

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[33] The distribution, unpublished, is the result of a survey of 33 universities made by the School of Business and Industry of Mississippi State University.

These figures were used to form weighted average indices for the graduate division (4.16) and the undergraduate division (1.40), using as weights estimates of the number of student enrollments in each of the six groups.[34] The ratio of the two weighted averages is 2.97 and the approximate value of 3 was taken to represent the cost incurred for a graduate student for one year, exclusive of Organized Research, relative to that for an undergraduate. The figure is conservative when compared with other estimates that have been made.

The expenditures for Educational and General Purposes, other than Organized Research, for graduate education per student can be computed, using this ratio, from information concerning the corresponding total Educational and General Purposes expenditures of the institutions with graduate programs and the total numbers of graduate and undergraduate enrollments in these institutions.[35] This computation has been carried out, using data made available by the Office of Education (DHEW) for universities from biennial surveys for the years from 1951-1952 to 1963-1964 inclusive. Corresponding expenditures for Organized Research per graduate student were obtained from the simple ratio of expenditures for Organized Research to the number of graduate students. The results, together with projections to 1981-1982, are shown in Table 3-8.

Total expenditures for graduate education were estimated by multiplying the figures of Table 3-8 by the total number of graduate enrollments. In so doing, a further approximation has been made through the assumption that all graduate students are enrolled in universities or, alternatively, that expenditures are

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[34] The number of graduate students in each group was determined for the Fall of 1964 from published data of the Office of Education (DHEW). Rough estimates of the number of undergraduates in each group were made for the year 1962-1963, using Office of Education data and Publication No. OE-54001-62, *Junior Year Science, Mathematics, and Foreign-Language Students, First-Term 1962-1963*, and assuming that "first-time opening fall degree-credit enrollment in 4-year institutions of higher education" could be identified with freshmen and baccalaureates with seniors.

[35] If C denotes the Educational and General Purposes expenditures of the institution(s), C(G) the expenditures per graduate student, U the number of undergraduates, and G the number of graduate students, then

$$C(G) = 3\,C / U + 3\,G$$

Table 3-8

PROJECTED COST OF GRADUATE EDUCATION PER STUDENT (1)

Year	Cost of Instruction	Organized Research	Total
1951-1952	$1,720	$1,120	$2,840
1953-1954	1,840	1,090	2,930
1955-1956	2,290	1,680	3,980
1957-1958	2,620	2,160	4,780
1959-1960	2,790	2,470	5,260
1961-1962	3,070	2,930	6,000
1963-1964	3,370	3,130	6,500
1965-1966	3,650	3,630	7,280
1967-1968	3,970	4,120	8,090
1969-1970	4,330	4,660	8.990
1971-1972	4,710	5,280	9,990
1973-1974	5,130	5,970	11,100
1975-1976	5,580	6,750	12,330
1977-1978	6,080	7,620	13,700
1979-1980	6,620	8,600	15,220
1981-1982	7,200	9,700	16,900

(1) Because of changes of definition prior to 1957-1958 which affect the early detailed trend behavior, projections have been based on a least squares computation beginning with 1957-1958:

Cost of Instruction: $\log y = 3.3778 + 0.0369 \cdot x$

Total Cost: $\log y = 3.6339 + 0.0457 \cdot x$

where a unit of x corresponds to 2 years (1955-1956 corresponding to $x = 0$).

Source: Computed from data made available by the Office of Education (DHEW).

comparable in institutions that award the master's degree as the highest degree. The results, including projections to academic year 1981-1982, are shown in Table 3-9.[36]

It is of interest to compare the projected expenditures for Educational and General Purposes (including Organized or Sponsored Research) for graduate education with those for higher education as a whole. This comparison is made in Figure 3-2. It will be noted that, in spite of the disparate numbers of students involved, expenditures for graduate education in 1979-1980 will exceed those for the rest of higher education, providing these estimates are representative of the situation that will prevail. The crossover is projected to occur during the early 1970's. Thereafter, graduate education will be not only the most expensive form of education **per student** but also the most expensive form of education in terms of total expenditures.

EXPENDITURES FOR THE PHYSICAL PLANT

Equally uncertain are estimates of projected expenditures for the physical facilities required by graduate education. In Table 3-10 such an estimate is presented, however, to illustrate the order of magnitude involved. This computation has been based on the following assumptions and procedures:

1. It is assumed that 250 square feet of net usable space are required by each full-time professional person.[37]
2. The 1967 cost of such space (laboratories, offices, classrooms, etc.) is taken to be $55 per net usable square foot.[37]
3. The product of these two ($13,750 per professional person) is assumed to double in 10 years. The average annual rate of increase of 7.2 percent consists of an estimated 3.0 percent for general price inflation and an addi-

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[36] The total number of graduate and undergraduate enrollments was used in this computation. If the number of full-time equivalent enrollments (full-time plus one-third part-time) were used instead, the Cost of Instruction in Table 3-9 would be *increased* by approximately 25 percent for academic year 1965-1966, and the Cost of Graduate Education by about 12 percent. The totals of Table 3-9 are thus conservative.

[37] Estimates by the National Science Foundation.

Table 3 - 9

PROJECTED COST OF GRADUATE EDUCATION (1)

(Dollars in billions)

Year	Cost of Instruction	Organized Research	Total	% of GNP (2)
1951-1952	$ 0.400	$ 0.260	$ 0.660	0.20
1953-1954	0.510	0.300	0.820	0.22
1955-1956	0.580	0.420	1.000	0.25
1957-1958	0.730	0.600	1.330	0.30
1959-1960	0.960	0.850	1.810	0.37
1961-1962	1.220	1.170	2.390	0.46
1963-1964	1.620	1.500	3.110	0.53
1965-1966	2.120	2.120	4.240	0.62
1967-1968	2.820	2.920	5.740	0.74
1969-1970	3.400	3.670	7.070	0.82
1971-1972	4.110	4.610	8.720	0.91
1973-1974	5.040	5.870	10.910	1.02
1975-1976	6.080	7.360	13.440	1.13
1977-1978	7.120	8.930	16.040	1.22
1979-1980	8.370	10.880	19.250	1.31
1981-1982	9.660	13.000	22.660	1.39

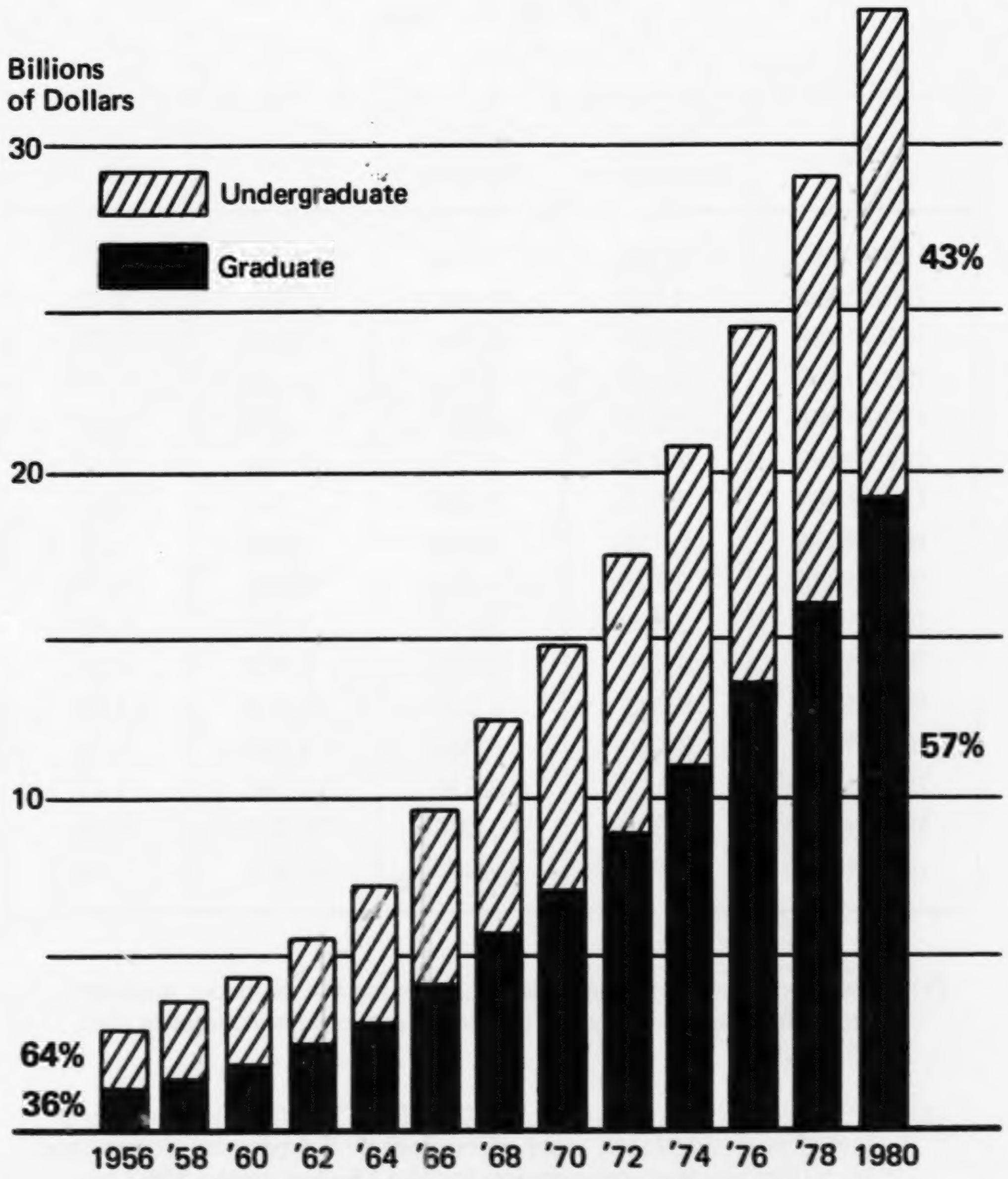
(1) Projections were obtained by multiplying the costs per graduate student (Table 3-8) by the projected graduate enrollments (See Chapter I).

(2) The Gross National Product, in CURRENT dollars, has been projected at an ANNUAL rate of increase of 5.4 percent, determined by a least squares computation for the 15-year period 1952 to 1966 inclusive. Academic year expenditures have been related to the Gross National Product of the year of the fall term.

Figure 3-2

PROJECTED COST OF GRADUATE EDUCATION

Expenditures for Educational and General Purposes (Current Dollars)



Estimate of cost of graduate education and projection to 1979-80 by National Science Foundation.

Source: Office of Education (DHEW) projections for higher education to 1975-76; graphical extrapolation to 1979-80.

Table 3-10

PROJECTED EXPENDITURES FOR PHYSICAL PLANT

Fall of Year	Expenditures (Dollars in millions)	Fall of Year	Expenditures (Dollars in millions)
1967	$ 1,100	1974	1,790
1968	990	1975	1,990
1969	790	1976	2,240
1970	930	1977	2,510
1971	1,330	1978	2,720
1972	1,500	1979	3,070
1973	1,690	1980	3,390

Source: Enrollment figures from Office of Education (DHEW); student-faculty ratios and estimates of space requirements and construction costs from National Science Foundation.

tional increase of about 4 percent to provide for increasing complexity of graduate research activities.

4. Three part-time graduate students are assumed to be the equivalent of one full-time graduate student.

5. On the average there are 3.4 full-time-equivalent graduate students and 0.175 postdoctoral students per member of the graduate faculty.[38]

6. In addition to new space required for additional students, faculty, and postdoctorals, 4 percent of the space installed in a given year is reconstructed in each of the subsequent years over the time period shown in Table 3-10. This figure is assumed in order to provide for repair, modification, or replacement of facilities. This computation begins with assumed construction in 1967 of 4 percent of the total installed facilities in being in 1966, this figure being estimated from the total calculated professional personnel in 1966.

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[38] *Graduate Student Support and Manpower Resources in Graduate Science Education, op. cit.*, pp. 59 ff.

(no p.162)

SUMMARY

This review of graduate education in the United States emphasizes institutional aspects, rather than programmatic or methodological features of the graduate endeavor itself. It is concerned primarily with the array of institutions that offer graduate programs, their quality, and their financial support. The analyses and data here considered lead to a number of conclusions with important policy implications for national planning for graduate education during the next decade.

INSTITUTIONAL CAPACITY

At present, graduate students in all disciplines, both full-time and part-time, number approximately three-quarters of a million, a figure that is expected nearly to double by the early 1980's. The increase itself will thus be comparable to the total college and university enrollment in the United States in the mid-1920's. This prospect alone, however, does not imply any necessary multiplication of the number of graduate institutions.

(1) There is an average of about 3800 graduate students in each of the 50 universities with the highest quality graduate programs. About 360 institutions of this average size could accommodate the entire graduate student population in 1980; however, there were already about 700 institutions offering graduate work in 1965, including more than 400 with programs in the natural and social sciences and engineering.

(2) Although there is evidence that higher graduate student-faculty ratios are associated with higher quality, while many institutions lack sufficient numbers of qualified graduate students to achieve these higher ratios, about 10 institutions are being added each year to the number offering graduate programs, at the level of either the master's degree or the doctorate.

(3) Evidence that the transition to graduate status can be hazardous is provided by the facts that (a) of the 157 institutions that aspired, over a ten-year period, to become master's degree institutions, 41 percent retreated from the

effort, while (b) nearly 31 percent of the 65 institutions that undertook doctoral programs gave up the attempt.

(4) Institutions with graduate programs form two distinct types. More than 200 institutions that offer graduate training in the sciences and engineering award the master's degree as the highest degree; in these institutions there is a median enrollment in the range of 32 to 56 graduate students. Conversely, more than 200 institutions award the doctorate; the median enrollment, however, lies in the range of 317 to 562 graduate students in science and engineering. Graduate institutional capacity during the next decade will thus be provided predominantly by the doctorate-granting universities.

GEOGRAPHICAL DISTRIBUTION

There are now universities with doctoral programs in every State of the Nation. On the average, in the United States, there are about 265 graduate students per 100,000 population. This ratio, however, varies widely among the States: in five States it exceeds 400; in seven it is smaller than 100. Altogether, there are 35 States that fall below this average. In each of 10 States additional graduate educational capacity of at least 3700 graduate students would be required to achieve this ratio, that is, the equivalent of at least one major university per State, equal to the average of the 50 universities of highest quality in the Nation.

(1) The position of a State with respect to graduate enrollments is roughly equivalent to its position with respect to doctoral awards. Thus, in the sciences and engineering, of 31 States that were below the national average of graduate enrollments (96 per 100,000 population in academic year 1964-1965), 27 were also below the national average of doctorates granted (57 per 1,000,000 population).

(2) It can be shown that there is a positive correlation between the ratio of graduate enrollments to population, especially for States that lie below the national average, and *per capita* personal income. This is a matter of great importance to national planning for the support and development of graduate education, for only if graduate educational

capability exists can it contribute to the social and economic well-being of a region.

(3) Although graduate students are characterized by great mobility, so that many universities are in fact national institutions, 56 percent of the graduate students of the Nation are, nevertheless, part-time students. This circumstance implies large urban centers of graduate education. In the sciences and engineering 79 percent of the Nation's graduate students are enrolled in institutions within metropolitan areas. Again, however, the distribution is uneven. In seven States all graduate students in science and engineering are located in metropolitan areas; in five States there are no graduate students in metropolitan areas. Even within major metropolitan areas the distribution is exceedingly uneven. For example, of 55 metropolitan areas with population of 500,000 or greater, there are 14 with no doctoral capability in the sciences and engineering.

(4) The quality of graduate education also varies greatly across the Nation. The distribution corresponds roughly to that of *per capita* graduate enrollments. Thus, in two of the nine census divisions of the United States a graduate student has better than an even chance of being enrolled in one of the 50 institutions of highest quality; in three census divisions the chances are more than four to one against this opportunity.

INSTITUTIONAL QUALITY

It is the function of graduate education to prepare individuals to perform as professionals in public service, including teaching, or in a broad area of research or development; there can be no justification for planning less than the highest possible quality for this educational experience. Accordingly, the characteristics of high quality in graduate education are a matter of national importance.

(1) One of the fundamental conclusions of this report, well supported by the evidence, is that quality is an attribute of the total institution, not merely that of one or more of its

parts, including the graduate division. This aspect of quality is of the greatest significance in formulating plans for the improvement of quality.

(2) Although the achievement of large size will not ensure high quality, for the most part high quality graduate institutions are large institutions, high quality academic departments are large departments, and high quality graduate programs tend to be characterized, as already noted, by relatively large student-faculty ratios.

(3) Three circumstances support this emphasis on size: (a) high quality graduate institutions have generally made a significant commitment to graduate education in terms of size relative to the undergraduate divisions; (b) high quality graduate institutions have large resources of funding from various sources, faculty, libraries, and research facilities; and (c) well qualified students, responding to the presence of these resources, seek admission to the highest quality institutions, thus both contributing to their quality and, at the same time, generating pressures for expansion.

(4) The most critical resource of the graduate institution is its faculty. Within the faculty, the position of the full professors is an important correlate of institutional quality. Not only do full professors in the highest quality institutions form numerically the largest faculty rank, but their compensation, in national competition, is a decisive factor in establishing and maintaining the quality of the institution.

(5) Partly through the formation of new graduate institutions, partly through the growth of institutions of lesser quality, the average quality of graduate education, considered in terms of the annual number of doctorates awarded, may decline during the next decade, unless steps are taken to offset the trend. Although the growth and development of graduate institutions is clearly in the national interest, the time and resources that must normally be invested in building and maintaining high quality imply an issue of public policy of the greatest difficulty. Considerations of cost-effectiveness suggest that more is accomplished by develop-

ing institutions within reach of the highest quality; considerations of public need in all geographical regions suggest that the selective, aggressive, and planned formation and development of additional institutions are also urgently required.

FINANCIAL SUPPORT

Graduate education is already the most expensive form of education *per student*, and current projections indicate that during the early 1970's the total cost of graduate education will exceed, for the first time, the cost of the remainder of higher education. By 1980 the cost of graduate education may attain an annual rate of $20 billion, with annual expenditures for the physical plant of the order of $3 billion, both estimates taking into account characteristic factors for inflation and increased complexity of research activities.

(1) The only major source of income of universities, either publicly or privately controlled, that has consistently demonstrated a relative increase during the period since World War II has been Federal research funding. This source of funds has been vital to the impressive growth of graduate education in the United States, as well as to the success of American science and engineering. There is no evidence that graduate educational goals for 1980 can be achieved without the active, growing participation of the Federal Government in this endeavor.

(2) The Federal Government, however, has supported graduate education largely by indirection. While Federal research funding has formed an increasingly important part of university income for educational and general purposes, this funding has been provided in large measure through research grants and contracts by Federal agencies whose missions have required the results of the research supported. The universities have thus been in competition with industrial and other organizations, designed to provide a research service.

(3) Furthermore, Federal research grants and contracts to universities have been negotiated and audited within a cost accounting framework. To the extent that this procurement

practice has involved such matters as faculty salaries and student support, it has served to remove significant elements of university operations from the purview of effective institutional planning and administration.

The material presented in this report thus implies major issues of public policy. These issues concern (a) the capacity of the educational system to meet the challenges of the next ten years, (b) the achievement and maintenance of the quality of the graduate endeavor, without which the value of the graduate enterprise to the Nation becomes illusory, (c) the deployment of graduate educational capacity to ensure maximum benefit to society, and (d) the role of the Federal Government in relation to graduate education and the means by which this role can best be exercised, especially insofar as it affects the balanced planning and development of individual institutions.

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